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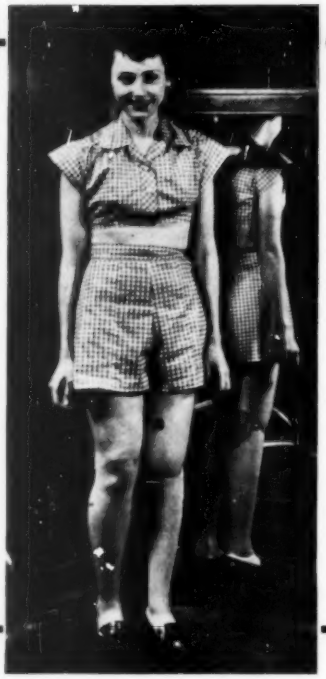

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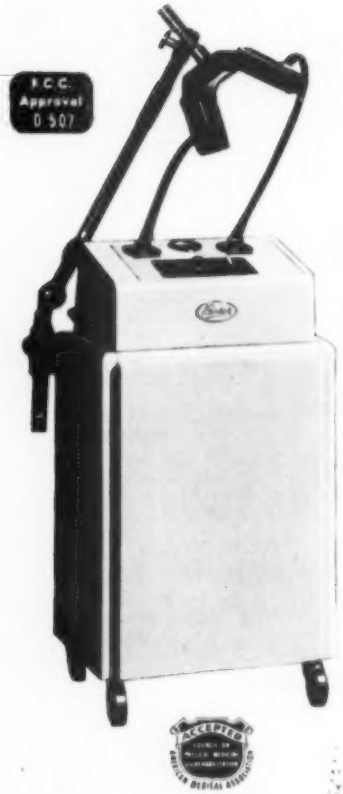

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GAIT STUDIES OF THE HEMIPLEGIC PATIENT AND THEIR CLINICAL APPLICATIONS *

Stroboscopic and Force Plate Studies

MORTON MARKS, M.D.

NEW YORK, N. Y.

Despite the recent and apparently increasing appreciation of the values of and need for rehabilitation, there is an awareness by those actively engaged in this phase of medicine of the need for continual improvement of the techniques used in training the patient to minimize the severity of his residual deficits. It seems likely, however, that the greatest advances will occur only after the basic disability patterns are objectively understood.

Although the hemiplegic patient is one of the most common problems encountered and the time devoted to gait training is considerable, objective analyses of the basic motor patterns responsible for his gait abnormalities have not been extensively investigated. Wortis, Marks, Hirschberg and Nathanson[1-2] have described the muscular activity of the hemiplegic as recorded by the electromyograph; however, although studies of the human gait have been attempted by numerous investigators, they have primarily been directed at the normal person or the patient with various orthopedic disabilities. Of recent investigators, the work of Steindler[3] and R. Plato Schwartz[4-13] and co-workers must especially be commended. Schwartz and Heath[5] reviewed the status of the study of gait until 1932, and their paper is worth reviewing. Recording techniques have continued to improve. With the development of the force plate, an instrument designed especially for the analysis of gait patterns is now available which seems to be potentially extremely valuable. Devised by Elftman[14] in 1938, it has grown into a complex apparatus to measure the ground reactions developed during walking, i. e., the forces developed during the period of contact of the lower extremity with the ground during the stance phase. Simultaneously, using an interrupted light camera similar to that developed by Marey,[15] a stroboscopic photograph of the test subject can be obtained for the period during which the ground reactions are recorded.

* From the Departments of Neurology and Physical Medicine and Rehabilitation, New York University, College of Medicine.

* Presented at the American Congress of Physical Medicine and Rehabilitation, New York, N. Y., August 28, 1952.

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This photograph records the relative positions of the various segments of lower extremity to each other and in space throughout the walking cycle. The joint movements, i. e., the angular forces developed at the joints, can be calculated from correlating the ground reactions with the exact position of the limb at a given time. These methods have been extensively employed in the study of amputees, directed primarily at the design and perfection of artificial lower limbs that will duplicate the gait characteristics of the normal person.[16-17] The method is potentially useful, however, for the study of any gait aberration.

In this study the gait abnormalities of the hemiplegic patient were investigated, and an attempt was made to evaluate objectively the usefulness of the short leg brace and the effect of gait training.

Patient Material

The gait characteristics of 11 moderately spastic hemiplegics have been studied. In all the cases the disturbance was ascribed to antecedent vascular accidents in the distribution of the middle cerebral artery, 6 weeks to 3 years prior to the study (table 1). The results of the right hemiplegic were compared with those of the left hemiplegic. Control records were obtained from normal subjects.

TABLE 1. — *Patients Studied.*

Subject	Age	Sex	Onset of Symptoms	Disability	Date of Test	Approx. Brace Wearing Time	Test Braced	Status Unbraced
					3-27-50			
B. F.	46	F	1-29-50	Rt. Hemi.	4-21-50	1 week	X	X
E. P.	49	M	2-23-49	Lf. Hemi.	5- 5-50	8 months (discarded)	....	X
G. W.	44	M	7-14-49	Rt. Hemi.	5- 5-50	6 months	X	X
T. R.	28	M	10-25-49	Lf. Hemi.	5- 5-50	3 months	X	X
W. C.	62	M	3- ? 50	Rt. Hemi.	6- 2-50	3 weeks	X	X
J. C.	70	M	9-20-49	Rt. Hemi.	6- 2-50	2 months	X	....
J. D.	17	M	2- 8-47	Rt. Hemi.	6-16-50	0	....	X
E. B.	50	M	11- ?-49	Lf. Hemi.	6-16-50	0	....	X
J. S.	49	M	12- 9-49	Rt. Hemi.	6-30-50	1 week	X	X
J. H.	61	M	5-26-50	Lf. Hemi.	7-14-50	0	....	X
J. N.	66	M	8- ?-49	Rt. Hemi.	7-14-50	10 months	X	X

Test Equipment

1. *Force Plate.* — The force plate is a specially suspended platform mounted flush with a forty-foot wooden walkway, and placed approximately at the walk-away center. Readings may be made in either walking direction. Bolted to a cement base, the force plate is composed of two equilateral right triangular sections fitted so as to form a square roughly forty inches on a side. Each plate half is independent in its mounting. The mounting in each case consists of six support beams, each attached to the plate top with a turnbuckle link (Fig. 1).

Each of these restraints measures forces in only one plane, and permits free motion in the other two. The beam link insets are so arranged that three, one at each apex of the triangle, support the plate vertically, and record the vertical forces. Two restraints record the fore and aft forces, and one the lateral forces. Each bending beam is reduced in section to localize and in-

16. Investigation with Respect to the Design, Construction and Evaluation of Prosthetic Devices. 2 Vols. Research Division College of Engineering, New York University, 1949.

17. Report to National Research Council. Fundamental Studies of Human Locomotion and Other Information Related to Design of Artificial Limbs. 2 Vols. College of Engineering, University of California, Berkeley, 1947.

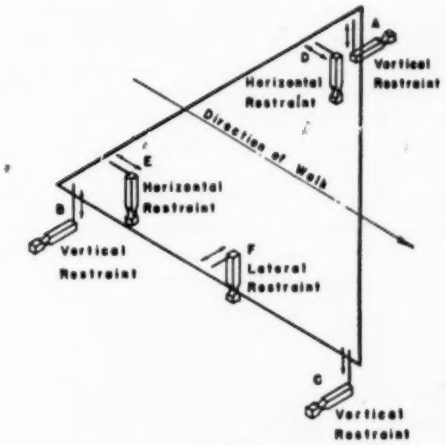

Fig. 1. — Schematic diagram of the dynamic force plate.

tensify the stress produced by plate-loading (Fig. 2). At this site, strain gages are mounted. They are temperature-compensated and record both compressive and tensile stresses. A deflection of the bending beam alters the resistance to an electric current flowing through the strain gage proportionately to the stress developed. This change unbalances a Wheatstone bridge circuit, is amplified, routed through a string galvanometer and recorded photographically. Through calibration, the forces developed in pounds can be calculated. Figure 3 represents a characteristic record. The sums A + B + C yield the total vertical force developed; E + F the fore and aft forces; and D the lateral force.

2. *Interrupted Light Camera.* — This device consists of a rotating shutter providing intermittent exposures. It is so coupled that it integrates the exposures with the corresponding force plate reading. The photographic system is designed to be activated by the subject as he passes in front of a photoelectric cell, steps on the force plate, and then finishes the exposure by pass-

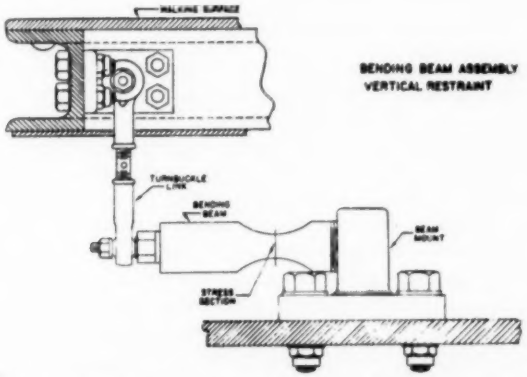

Fig. 2. — Detail of one restraint and its bending beam assembly.

ing in front of a second photo-electric cell. The rotating shutter is driven by a geared synchronous motor at 20 revolutions per second. A sector in the shutter permits one exposure per revolution. The exposure is 1/500 second upon Kodak Super Panchro-Press Type B film. Microswitches are arranged to record a deflection on the force plate oscillograph record each time an exposure is made. Timing cams are so adjusted that the sequence cannot be started or finished in mid-exposure.

3. *Oscillography.* — This is a type PA Universal Oscillograph manufactured by Westinghouse. It is a mechanically operated electromagnetic instrument, measuring electrical quantities as a function of time on photographic paper. The frequency range varies from zero or constant quantity to a frequency greater than 4,200 cycles per second; the response is flat to within 2 per cent for frequencies below 1250 cycles per second. The seven galvanometers record on Kodak Linagraph 697 paper carried in a 200-foot magazine. Development procedures are those conventionally applied to low contrast enlarging paper. After washing, the record is dried in a rotating Fedco dryer, care being taken to avoid ferrotyping of the record face.

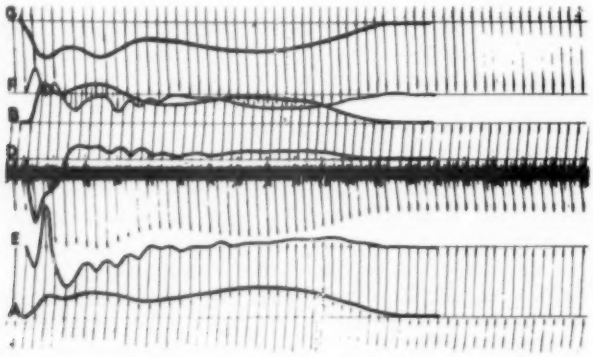

Fig. 3. — Typical oscillographic record marked to show the successive forces developed as a continuum.

4. *Projector.* — The oscillographic records are enlarged, using the opaque feature of a Bausch and Lomb projector type 41-23-81. A special carrier has been constructed, permitting precise alignment. The enlargement of approximately ten times allows accurate measurements of amplitude to be made.

Test Procedure

The subject is clothed in black tights. A white stripe is mounted on the shoe, and jointed to a similar white stripe sewn to the tights, outlining the axis of the lower limb. Joint markers (ankle, knee, hip) are placed on the stripe. The subject walks at a self-chosen comfortable pace. Several preliminary runs are conducted during which the subject's starting point is positioned to enable him to strike the plate in as natural a manner as possible. This procedure is simplified by the large triangular shape of the plates. The subject with a short stride is positioned on the walkaway so as to strike near the apex of the triangle, while the large stride subject is positioned to strike near the broad base. As the subject ambulates, the oscillograph drive is started, and the rotating shutter of the interrupted light camera switched on. When he crosses the path of the photo-electric cell, the camera shutter is opened, and simultaneously the time marker is activated. After the subject

crosses the plate, a second photo-electric cell is activated, the camera shutter is closed, and the time marker cuts out. The resultant picture shows the relative position of each segment of the lower limb at 1/20 second intervals throughout the walking cycle (Fig. 4).

By the use of this technique, information is gained relative to one lower extremity in the course of one run. It is necessary to have the patient repeat the procedure, walking in the opposite direction, to gather comparable data for the other leg. In each study, information was obtained for the nonparetic as well as the paretic limb. Whenever possible (six patients), the gait pat-

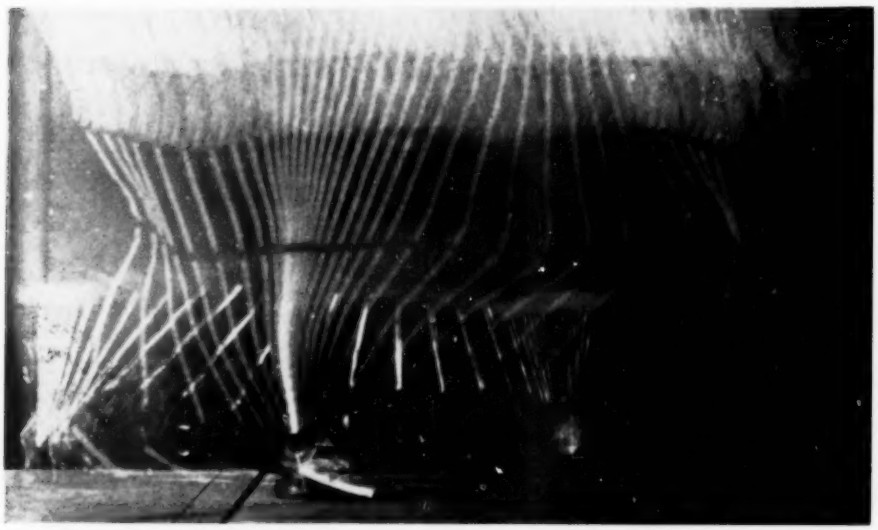

Fig. 4. — Stroboscopic photographs of a left hemiplegic, braced, walking across the force plate. The right leg is being analyzed

terns in both extremities were evaluated with and without the patient wearing his brace. In all the cases, the brace was a short leg, double bar, with stirrup attachment, foot plate and a 90 degree stop.

Evaluation

Evaluation is a lengthy and complex affair. Calibrations of the force plate must be conducted every operating day. Corrections must be applied to the data for numerous factors, including interaction, photographic lens aberrations, photographic paper distortion, parallax and photographic perspective. We have been primarily concerned with the total vertical pressures. By correlating these data with measurements of the corresponding knee joint angles which were computed from the stroboscopic photographs, the knee movements, i. e., the angular forces acting at the knee, were plotted for the period of the stance phase.

Results

1. *Vertical Loads.* — The significant findings during the stance phase were analyzed, and the vertical accelerations of the body were recorded by the force plate as it becomes weightbearing. Figure 5 reveals the typical pattern of the normal subject, which is characterized by two peaks corresponding to the beginning and end of the swing phase of the opposite leg. In the normal

pattern the vertical load increases rapidly as contact with the ground is made, to reach a peak load greater than the weight of the subject. This attests to an acceleration greater than the normal acceleration of gravity, i. e., greater than the familiar unit $g = 981$ cm. per second per second. As the area of con-

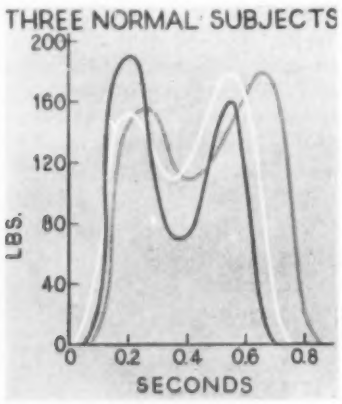

Fig. 5. — Vertical pressure curves of the normal.

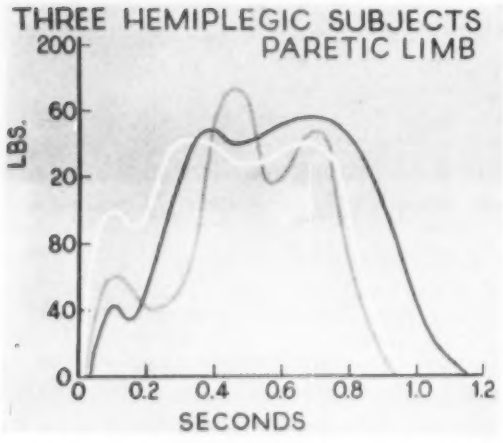

Fig. 6. — Vertical pressure curves of the paretic limb of the hemiplegic.

tact moves forward from the heel and the foot is more solidly placed, the process of swinging the other leg through is initiated, and at the time the vertical load drops to a minimum value. As the swinging extremity passes the plane of the center of gravity, the vertical force is again increased, reaching a maximum at the beginning of the double stance phase. In the typical hemiplegic record obtained from the paretic lower extremity (Fig. 6), the vertical pressure curve is more variable and has an initial low peak. In general the trends are similar. This graph indicates that the vertical load build-up is accomplished in a step-like manner. Concomitant studies of the stroboscopic photographs disclosed that the normal subject strikes the ground with the knee in full extension. He then absorbs the resultant shock by a

slight knee flexion of 7 degrees, which is correlated with the negative knee movement (see below). The hemiplegic strikes the ground similarly with the knee in full extension, but there is little or no subsequent knee flexion. The resultant graphic representation records the shock acceleration noted as a third load peak.

A study of the nonparetic leg of the hemiplegic (Fig. 7) revealed the same characteristics as were noted on the paretic side. These findings, i. e., the abnormal motor patterns observed in paretic and nonparetic leg, were not significantly altered by brace-wearing and did not appear to be correlated with the degree of clinical recovery.

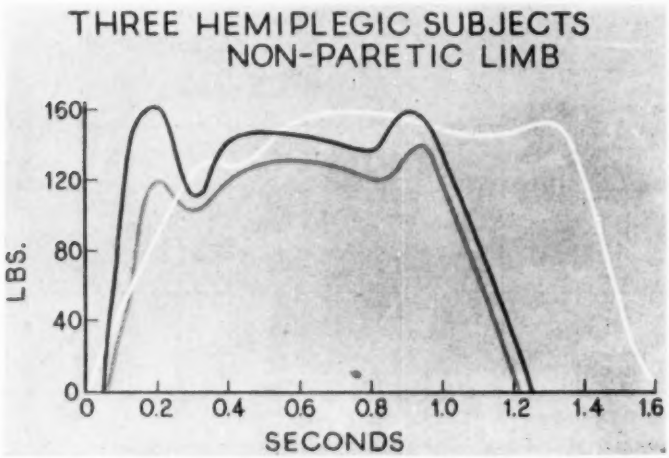

Fig. 7. — Vertical pressure curves of the nonparetic limb of the hemiplegic.

2. Knee Moment. — The knee moment is a measure of the angular force acting at the knee. A negative knee moment is associated with flexion, i. e., a collapsing movement. Positive knee moment is a movement of extension at the knee. The graphic characteristics of the hemiplegic patient's curve differs considerably from that of the normal. In the latter, the graph of the knee moment is "S" shaped, with an initial negative component followed by a positive one (Fig. 8). The negative knee moments correspond to the early stance phase. Correlated stroboscopic photographs show that, when the leg has become weightbearing, the knee flexes and sustains a negative or unlocking knee movement. As the body center of gravity rides over the plane of the foot position in the stance phase, the knee moment becomes strongly positive and approaches a magnitude of 300 to 500 inch pounds. In the hemiplegic, the knee moment in the paretic leg is strongly positive throughout the cycle (Fig. 9). The knee moment characteristics of the nonparetic leg are similar to those demonstrated on the paretic side, i. e., a large positive moment is present throughout the stance phase (Fig. 10). These characteristics persist whether or not the short leg brace is worn and seem independent of the extent of clinical recovery, or the particular side of the body involved (Figs. 11, 12).

Discussion

An unanticipated feature that became obvious from these studies was the observation that there are changes of a similar character in motor performance in the nonparetic as well as the paretic leg of the hemiplegic. This fact, convincingly demonstrated by the force plate and stroboscopic investigations, has also been corroborated by electromyographic studies in which the action potentials of the important muscle groups of the lower extremities were recorded during ambulation.[1,2] Here too, abnormal motor patterns of

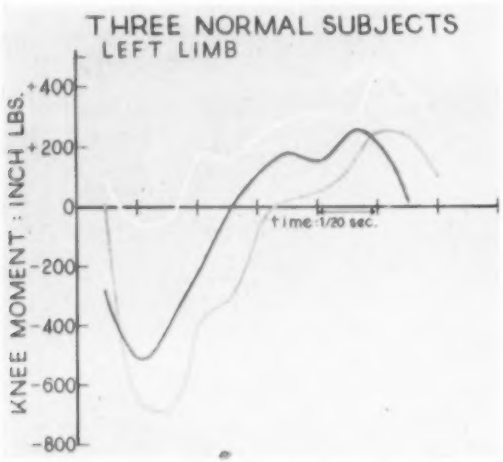

Fig. 8. — Knee moment characteristics of the normal.

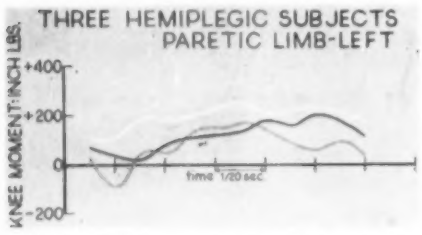

Fig. 9. — Knee moment characteristics of the paretic limb of the hemiplegic.

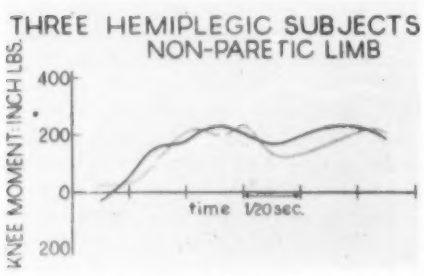

Fig. 10. — Knee moment characteristics of the nonparetic limb of the hemiplegic.

an essentially similar nature were observed in the nonparetic as well as the paretic lower extremity.

In attempting to explain this bilateral phenomenon, it was natural to question whether the stiff-knee effect of the paretic leg associated with the lack of a negative knee moment sets up a mechanical situation that is transferred into the nonparetic limb. To test this hypothesis, the findings obtained from the force plate and stroboscopic studies of a series of above knee amputees were examined. Each of these patients had been fitted with and trained in the use of an artificial lower extremity. With this type of prosthesis, it was impossible for the subject to develop a negative knee moment during the stance phase; nevertheless, the ground reactions on the uninvolved side were comparable to that of the normal (Fig. 13).

One is tempted to ascribe neurophysiologic significance to the fact that bilateral patterns of motor abnormalities are obvious with predominantly

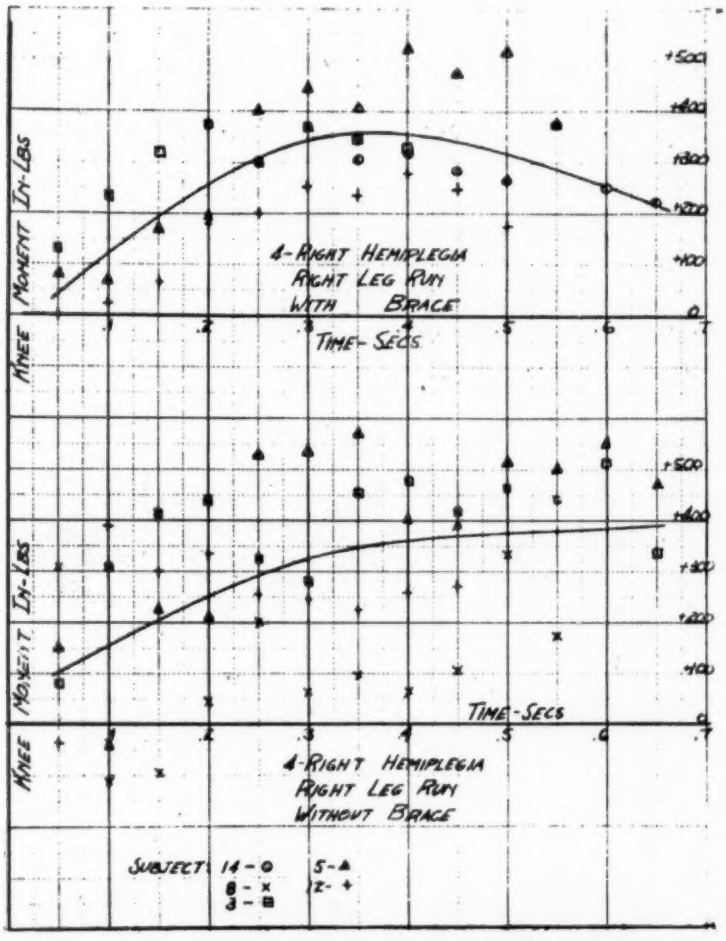

Fig. 11. — Knee moment characteristics of the paretic limb of the hemiplegic in the braced compared with the unbraced state.

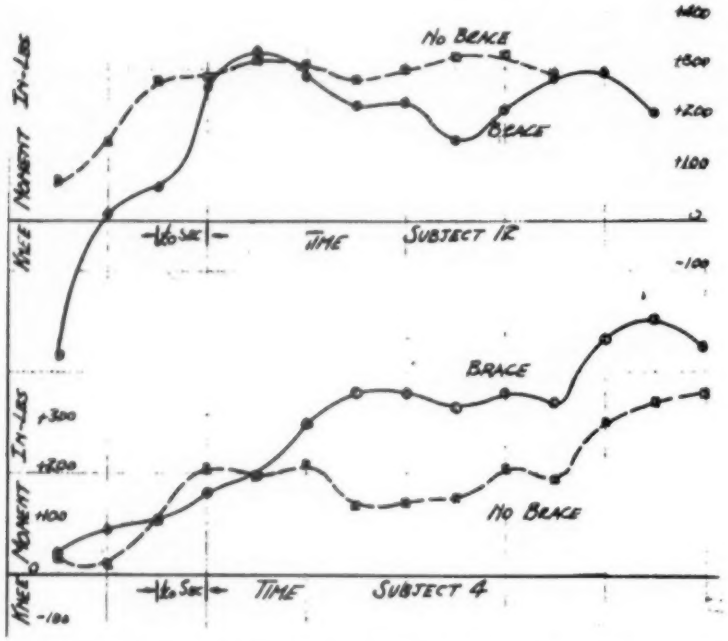

Fig. 12. — Knee moment characteristics of the nonparetic limb of the hemiplegic with the paretic limb braced and unbraced.

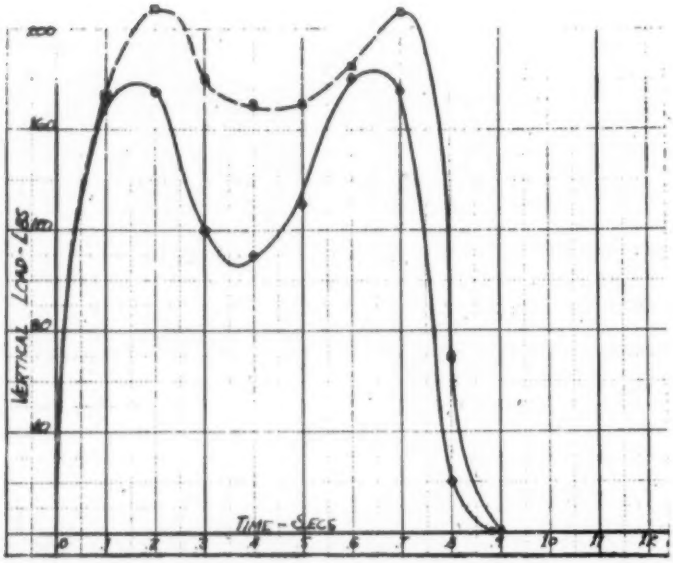

Fig. 13. — Vertical pressure curves of the uninvolved side of 2 above-knee amputees ambulating with artificial limbs.

unilateral brain damage. A number of observations suggest that the cerebral lesion itself directly alters the functional capabilities of the nonparetic or "normal" limb. It is a clinical fact that the hemiplegic patient frequently shows a defective performance, i. e., a dyspraxia in his ability to carry out alternative moments of the nonparetic limb, though not to the degree seen on the paretic side.[18] The knee jerks in the nonparetic limb are abnormal in many hemiplegics.[19] Shuster and Pineas[20] observed grasp abnormalities in the nonparetic upper extremity of the hemiplegic.

This accumulated evidence suggests that, although mechanical factors may play a role in the production of the bilateral patterns of motor abnormality in the patient with a unilateral brain lesion, other explanations must be considered. It is conceivable that these changes in motor performances may reflect the capabilities of the brain to undergo a reorganization of its functional capacities; in attempting to compensate for the deficiencies imposed by the pathologic process, the residual functional capacities may be performed at a lesser level of efficiency or in an abnormal fashion. Another possibility raised is that these are bilateral cerebral representations of motor patterns. Stimulation experiments in lower animals by Hering,[21] Tower[22] and others, which resulted in bilateral movement patterns, would seem to support the latter hypothesis. These are undoubtedly not the only possible explanations. Acceptance of one does not preclude the validity of or the acceptance of the other.

Another interesting feature noted in this study was that neither the wearing of the short leg brace nor the period of retraining significantly altered the observed motor patterns. From this it must not be assumed that these procedures are valueless in improving the gait of the hemiplegic patient. Unfortunately, the nature of this study was such that only the stance phase could be adequately investigated. Since the maximal benefit of the brace seems to occur immediately prior to the stance phase, in that the abnormal position of the foot is corrected, insuring the patient of a stable support on which he can bear weight, final objective evaluation must await a more detailed and comprehensive gait analysis in which both phases can be considered. The psychologic benefit the patient derives from the assurance that his paretic limb is relatively stable and that there is a lessened tendency for him to fall may be considerable.

What clinical significance do these studies have? The uniform occurrence of bilateral motor abnormalities in the patient with hemiparesis demands a reemphasis of the bilateral, reciprocal nature of gait. In gait retraining the movement patterns of the nonparetic as well as the paretic extremity must be carefully observed. Teaching the patient to merely lift his leg and to bend the knee of the paretic limb results in an abnormal pattern. A more physiologic one requires a "push off" to initiate the swing phase, which is correlated with the forceful contraction of the gastrocnemius muscle.

Despite the fact that the basic patterns of abnormality are similar, each hemiplegic patient's gait problem is a highly individualized one. It is not within the scope of this paper to consider the technical aspects of the retraining program itself. This will be the subject of a subsequent publication.

18. Cohn, R.: Interaction in Bilateral Simultaneous Voluntary Motor Functions, Arch. Neurol. & Psychiat. **65**:472, 1951.
19. Hirschberg, G. G., and Bergman, P.: Unpublished observations.
20. Schuster, P., and Pineas, H.: Weitere Beobachtungen über Zwangsgreifen und Nachgreifen und deren Beziehungen zu ähnlichen Bewegungsstörungen, Deutsche Ztschr. f. Nervenh. **91**:16, 1926.
21. Hering, H. E.: Ueber Grosshirnrindenreizung nach Durchschneidung der Pyramiden oder anderer Thiele des centralen Nervensystems mit besonderer Berucksichtigung der Rindenepilepsie. Wien. klin. Wschr. **12**:831, 1899.
22. Tower, S. S.: Extrapyramidal Action from the Cat's Cerebral Cortex: Motor and Inhibitory, Brain **59**:408, 1936.

However, before such a program can be considered, there are many factors that must be analyzed for *both lower extremities*. These include:

1. The patient's sense of balance;
2. The position and stability of the foot at the time of initiation of the stance phase;
3. The presence or absence of complicating foot conditions, e. g., corns, calluses, deformities;
4. The presence or absence of normally associated and involuntary movements, e. g., arm swing, ankle clonus, tremors;
5. Knowledge of the patient's kinesthetic sense appreciation, e. g., position sense in the toes, feet, etc.;
6. The strength of the intrinsic musculature;
7. The state of muscle tonicity; normal, flaccid, or spastic.
8. The muscle actions during both stance and swing phases, noting especially whether the gastrocnemius "push off" is present.
9. An estimate of the knee moment characteristics;
10. The influence the shoe and/or the brace has on the basic patterns.

When these have been determined, a meaningful gait program can be correctly prescribed.

Summary

The gaits of a series of hemiplegic patients were objectively investigated, utilizing the force plate and stroboscopic techniques. An analysis of the records disclosed abnormalities of motor performances of a similar character in the nonparetic as well as the paretic lower extremity. The short leg brace or a period of gait retraining did not significantly alter the patterns of abnormality observed. Some of the factors that must be considered before instituting a program of gait training are enumerated.

Acknowledgment — I wish to express my appreciation to the personnel of the Research Division of the College of Engineering, New York University and to Barbara White, R.P.T., and Dante Torres, R.P.T., for their technical assistance in these studies.

Discussion

Dr. John C. Allen (Hartford, Conn.): Dr. Marks is to be congratulated for this work and for the presentation of another objective method of evaluation which is so important in our work with physical disabilities.

Although the group on which the study was done was small, I believe the findings are valuable in that they serve to point out that although hemiplegia is essentially a one-sided involvement, the "good" leg is also involved. This point is all too frequently overlooked by rehabilitation personnel working with such a patient. As is pointed out in the paper, there can be several explanations for this. The need of the "push-off" in walking is emphasized rather than the lifting of the knee and foot. It is significant to note that the characteristic pattern of the hemiplegic does not present itself in the above-knee amputee, further emphasizing the neurological aspect of hemiplegia.

The many possible clinical applications have been mentioned by Dr. Marks, and there may be others.

I question whether these findings would hold in the instance of the developing child. Apparently, no work has yet been done in this direction. It would be interesting to know whether Dr. Marks contemplates any investigation in the field of congenital hemiplegia. Our thanks to Dr. Marks for his excellent paper.

EFFECTS OF ULTRASOUND ON GROWING BONE

An Experimental Study *

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Numerous reports in the European literature regarding the effects of ultrasonic energy on animal bone and diseases of the human musculoskeletal system have served as a stimulus to the undertaking of this study. It was felt that further basic investigation into the effects of ultrasound on normal growing bone was necessary before advocating the clinical use of this agent. The purpose of this investigation was to determine the effects of ultrasonic energy on the upper tibial epiphyseal region and adjacent structures of the dog and rabbit.

Previous Investigations

Freundlich, Söllner and Rogowski,[1] in 1932, applied ultrasonic energy of 300 kilocycles per second to the tibia of a dead lamb. Rises of 10 to 12 C. in temperature were recorded. They noted when applying ultrasonic energy to the tibia that rises of temperature were also observed in the femur. This indicated that ultrasonic energy was transmitted through the knee joint.

Buchtala[2,3] exposed the knee-joint region of young dogs to ultrasound from a generator having a frequency of 1,000 kilocycles per second and a maximal output of 36 total watts (ultrasonic power). When the ultrasound was applied by use of a nonmoving technique, doses of 4 watts for ten minutes given two times produced no change in the bone. When 8 watts were applied once for either five or ten minutes, destruction of bone was observed; higher doses all produced destruction of bone. When a moving technique was employed, doses of 4 watts for ten minutes applied three times produced no alterations of bone. The author reported that 8 watts applied for either five or ten minutes and four to six times produced acceleration of growth in the epiphyseal cartilage and periostitis of the tibia, which was thought not to be a reaction to trauma but a stimulation of growth. Still higher doses produced gross destruction of bone. Buchtala cautioned against the use of ultrasound on children.

* Abridgment of thesis submitted by Dr. DeForest to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Physical Medicine.

1. Freundlich, H.; Sollner, K., and Rogowski, F.: Eine biologische Wirkungen von Ultraschallwellen, Klin. Wchnschr. **11**:1512 (Sept.) 1932.
2. Buchtala, Viktor: Die Ultraschallwirkung auf den wachsenden Knochen: Ergebnisse tierexperimenteller Untersuchungen an jungen Hunder, Strahlentherapie, **78**:127 (Oct.) 1948.
3. Buchtala, Viktor: Die Ultraschallwirkung auf den wachsenden Knochen (II): Histologischer Teil, Strahlentherapie, **80**:317 (Oct.) 1949.

Barth and Bülow[4] exposed the epiphyseal regions of the lower part of the radius, lower part of the ulna, and upper part of the tibia and fibula to ultrasound of 800 kilocycles per second. A moving technique was employed. They considered that a dose of 3.25 watts per square centimeter (16.25 total watts) applied once for two minutes was the threshold dose above which damage to bone resulted. This dose, 3.25 watts per square centimeter, given for three minutes caused destruction of bone. They stated that 2.5 watts per square centimeter applied for two minutes and as many as fifteen times caused no damage to bone. They felt that ultrasonic therapy was not contraindicated in the treatment of children. They also expressed the opinion that a painless dose was a harmless one.

Majno[5] exposed the calcaneus of young rabbits to ultrasonic intensities of 67 watts for thirty to 120 minutes from a generator with a frequency of 960 kilocycles per second. He reported, on the basis of histologic examination, marked destruction of the epiphysis and diaphysis of the calcaneus, but stated that the epiphyseal cartilage was little affected. He felt that the cartilage was less susceptible to ultrasonic energy than was bone.

Barth and Kellner[6] studied the effects of ultrasonic energy on extremities of the rabbit with normal and interrupted blood supply. They found that destructive effects occurred in the midshaft of the radius, ulna, tibia and fibula in ischemic occluded and normal extremities after applications of 2.5 watts per square centimeter of ultrasound for five minutes. When pulsed waves were used, that is, 4 watts per square centimeter for fifteen minutes with a pulse of thirty milliseconds on and thirty milliseconds off, no change occurred in the normal extremity; but mild destruction was found in the radius of the ischemic foreleg. They postulated that an extremity with an intact circulation carried away the heat generated in the bone so that no destruction resulted, while the ischemic extremity could not carry away the heat and thus damage to bone resulted.

Nelson, Herrick, and Krusen[7] studied the temperatures produced in bone marrow, bone cortex and adjacent structures by ultrasonic energy. These authors reported an average rise of 5.9 C. in bone cortex, 5.4 C. in bone marrow and 1.1 C. in adjacent muscle fifteen seconds after a dose of 3 watts of ultrasonic energy applied one and one-half minutes had been terminated. When a dose of 10 watts was applied for one and one-half minutes the temperature of the cortex rose 10.5 C., the marrow 10.3 C. and the muscle 2.2 C. They concluded that ultrasonic energy caused a selective heating of bone which is not possessed by any other form of diathermy.

Maintz[8] showed that callus formation and the healing of fractures in the long bones of rabbits were not stimulated by exposure to ultrasonic waves of a frequency of 800 kilocycles per second. Doses ranging from 0.5 watt to 2.5 watts per square centimeter were applied. The duration of the exposures ranged from one to five minutes. Five applications of each dose were administered.

Hildebrand[9] reported injurious effects of ultrasonic therapy. Small ul-

4. Barth, G., and Bülow, H. A.: Zur Frage der Ultraschallschädigung jugendlicher Knochen, Strahlentherapie. **79**:271 (May) 1949.
5. Majno, Guido: Experimentelle Knochen und Sehnenläsionen durch Ultraschall, Strahlentherapie. **81**:513 (Apr.) 1950.
6. Barth, G., and Kellner, K.: Über den Wirkungsmechanismus biologischer Ultraschallreaktionen. IV. Versuche an Kaninchenextremitäten bei normaler und unterbundenen Blutzirkulation, Strahlentherapie. **81**:654 (May) 1950.
7. Nelson, P. A.; Herrick, J. F., and Krusen, F. H.: Temperatures Produced in Bone Marrow, Bone and Adjacent Tissues by Ultrasonic Diathermy: An Experimental Study, Arch. Phys. Med. **31**:687 (Nov.) 1950.
8. Maintz, G.: Tierexperimentelle Untersuchungen über die Wirkung der Ultraschallwellen auf die Knochenregeneration, Strahlentherapie. **82**:631 (Sept.) 1950.
9. Hildenbrand, Hans: Untraschallschädigungen, Strahlentherapie. **82**:475 (Aug.) 1950.

cerated areas on the extremities of 2 patients increased in size after ultrasonic therapy. The area treated in 1 patient was a persistent wound at the site of a compound fracture which had united; the area treated in the other patient was an unhealed surgical wound made for the excision of a carcinoma.

Apparatus and Method

The ultrasonic generator used in this study was made by the Central Research Laboratories, Inc., of Red Wing, Minnesota. The maximal output of this machine was 15 watts as measured by a Siemens-Reiniger "ultrasound power meter." The quartz crystal had a diameter of 2.5 cm. and vibrated at a frequency of 800,000 cycles per second (fig. 1). This generator consisted of a radio oscillator and a coaxial cable which carried the alternating current

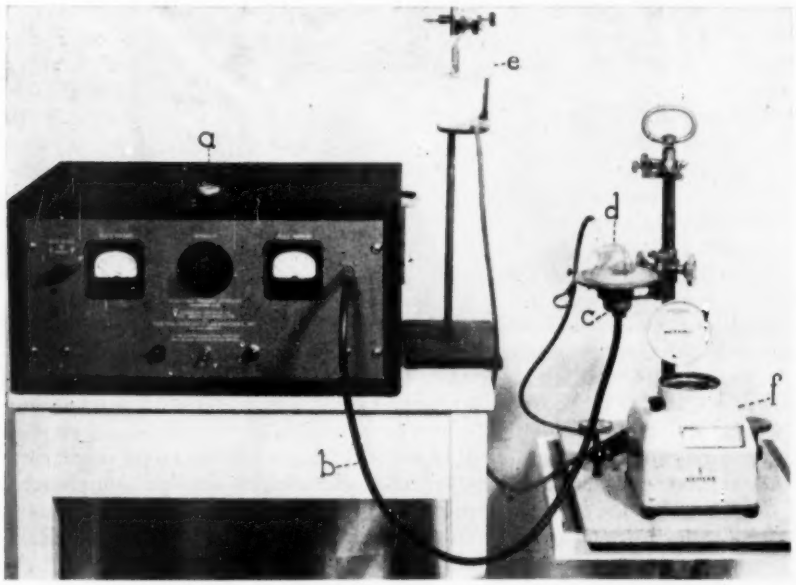

Fig. 1. — Apparatus used for the generation, measurement and application of ultrasound. a. Radio oscillator. b. Coaxial cable. c. Sound head. d. Plastic applicator. e. Water reservoir bottle. f. Ultrasound power meter.

from the radio oscillator to the sound head. The oscillator, coaxial cable and sound head were so constructed that no electromagnetic radiation could be detected in the ultrasonic field. A plastic applicator was designed so that the medial surface of the upper tibial epiphyseal region of the experimental animal would rest in water which served as a coupling medium between the sound head and the animal's leg. This water had been degassed by boiling. The plastic applicator was kept filled with this degassed water which flowed by gravity from a reservoir bottle.

This report is based on the observations made on 9 dogs aged 4 to 8 months and on 29 rabbits aged 3 to 8 weeks. The right hind leg served as a control. The left hind leg was shaved and the ultrasonic energy applied by resting the medial surface of the upper tibial epiphyseal region on the plastic applicator. Then the site of the epiphyseal cartilagenous plate was centered over the central portion of the ultrasonic field. Each animal was anesthetized with thiopental sodium (pentothal® sodium) administered intravenously in a

dose of 25 mg. per kilogram of body weight for the dogs and 15 mg. per kilogram of body weight for the rabbits. The surface of the plastic applicator, sound head and region of the animal's knee were coated with a thin layer of aerosol, a wetting agent. This was done to eliminate a surface layer of air on these parts and thus bring the coupling medium into better contact with the sound head and the animal. A moving technique was employed in all experiments. The extremity was moved back and forth across the surface of the applicator over a distance of 1.5 cm.

Question arose as to whether or not ultrasonic energy was being absorbed in the region of the epiphyseal plate. To answer this, ultrasound was applied to the upper tibial region of the dog and rabbit in the manner already described. Prior to this application thermistors as described by Herrick and Glarborg[10] were placed in the upper tibial epiphyseal line and in the knee joint of the dog and rabbit. Average rises in temperature fifteen seconds after termination of ultrasonic exposure in eleven experiments on 2 dogs were 7.1 C. in the epiphyseal plate and 1.1 C. in the knee joint after an exposure to 5 watts for five minutes. Four similar experiments on a rabbit revealed average rises of 11.0 C. in the epiphyseal plate and 1.4 C. in the knee joint, after exposure to 5 watts for five minutes. There was no rise in the rectal temperature. It was concluded that ultrasound was being absorbed in the upper tibial epiphyseal region of these animals.

Roentgenograms of the region of the right and left knees of each animal were made simultaneously just prior to the first ultrasonic application. They were made, in general, every week for four weeks thereafter and then at monthly intervals. Femoral and tibial lengths were obtained by direct application of a vernier caliper to the ends of the bone. The right tibial and femoral lengths were compared to left tibial and femoral lengths, respectively.

The animals were divided into three groups to correspond to the three basic doses used. The basic doses were as follows: 5 watts for five minutes, 10 watts for five minutes and 10 watts for ten minutes. Each animal received one or more applications of one of these basic doses. All animals reported on herein survived two weeks or longer after their initial ultrasonic application. Of the 29 rabbits, 17 were observed for as long as eighteen weeks after the initial ultrasonic application. The dogs were observed for twenty-four to twenty-nine weeks after their initial ultrasonic exposure.

Results and Comment

One of the most common findings after ultrasonic exposure was rarefaction in the upper tibial diaphyseal region (fig. 2). This was observed in 21 of the 29 rabbits and in 6 of the 9 dogs. Each dog showing this change received one of the following exposures: one or thirteen applications of 5 watts for five minutes, four, eleven or twenty-one applications of 10 watts for five minutes, and five applications of 10 watts for ten minutes. The dogs receiving, respectively, eleven and twenty-one applications of 10 watts for five minutes subsequently experienced complete resorption of a portion of the medial tibial plateau. Rabbits receiving six or twelve exposures of 5 watts for five minutes, six, nine, eight, twelve or thirteen exposures of 10 watts for five minutes, and six, nine, eight, ten or thirteen applications of 10 watts for ten minutes made up the group of 21 rabbits showing this change. Eighteen of these 21 rabbits had a dose of 10 watts for five minutes or a dose of 10 watts for ten minutes. Higher ultrasonic doses produced rarefaction in the upper tibial diaphyseal region more readily than did lower doses.

10. Herrick, J. F., and Glarborg, E. A.: Application of Thermistors to Temperature Measurements in Experimental Investigations, Proc. Minnesota Acad. Sc. 17:87, 1949.

Sclerotic changes in the upper tibial diaphyseal region occurred in 15 rabbits and 5 dogs. Two of the rabbits were in the group in which the dose was 5 watts for five minutes, 1 having received six and the other twelve applications; 9 were in the group in which the dose was 10 watts for five minutes, in which animals receiving six, nine, twelve or thirteen applications were represented (4 animals in the latter group having previously shown rarefaction in the same region), and 4 rabbits were in the group in which the dose was 10 watts for ten minutes, 1 receiving six applications, 1 receiving eight applications and 2 receiving thirteen applications (3 of these 4 having previously shown rarefaction in this sclerotic region). Among the 5 dogs showing sclerotic changes in the upper tibial diaphyseal region the following

Fig. 2a. — Lateral view of the left knee of a rabbit made five weeks and six days after the first (one day after the last) of six applications of 5 watts of ultrasound for five minutes. There is rarefaction in the upper tibial diaphyseal region. b. Lateral view of the right, or control, leg of the same rabbit as in a.

doses were represented: one application of 5 watts for five minutes, one application and twenty-one applications of 10 watts for five minutes (each of these animals subsequently experienced resorption of the medial tibial plateau and diaphysis just below it), and five and ten applications of 10 watts for ten minutes (the dog receiving ten applications subsequently experienced resorption of part of the lateral tibial plateau and diaphysis beneath it).

Fractures were observed in the upper tibial diaphyseal region in 7 rabbits and 3 dogs (fig. 3). Of the 7 rabbits, 2 received six applications and 2 received twelve applications of 5 watts for five minutes, 1 received twelve applications of 10 watts for five minutes, and 1 received six and another thirteen applications of 10 watts for ten minutes. In the case of the 3 dogs the following exposures were represented: thirteen, eleven and five applications of 5 watts for five minutes, 10 watts for five minutes and 10 watts for ten minutes, respectively. Fracture in the upper tibial diaphyseal region was observed more often in the groups receiving the small and medium doses (7 of the 10 animals having fractures fell in these groups). That the incidence might properly be expected to increase with increasing doses but does not do so is an indication of the unpredictability of ultrasonic effects on bone.

Widening of the upper tibial epiphyseal line occurred in 13 rabbits and 7 dogs (fig. 3). This widening was observed in rabbits receiving six, nine, twelve and thirteen ultrasonic exposures of 5 watts for five minutes, 10 watts for five minutes and 10 watts for ten minutes. The groups receiving 5 watts for five minutes and 10 watts for ten minutes accounted for 5 rabbits each,

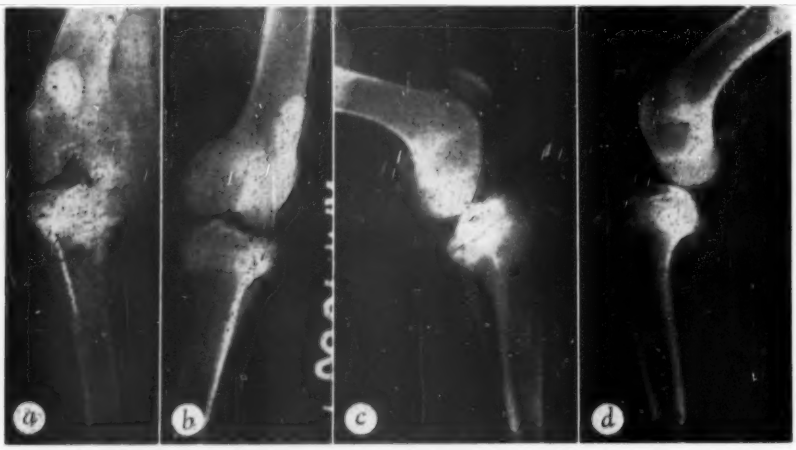

Fig. 3a. — Anteroposterior view of the left knee of a dog exposed to thirteen applications of 5 watts of ultrasound for five minutes. There are widening of the upper tibial epiphyseal line and fracture in the medial portion of the upper tibial diaphyseal region. b. Anteroposterior view of the right, or control, leg. c and d. Lateral views of the knees shown in a and b, respectively. All roentgenograms were made three weeks and six days after the first (one day after the last) ultrasonic application.

while there were only 3 rabbits in the group receiving 10 watts for five minutes. Dogs in which widening of the upper tibial epiphyseal line was observed were represented by the following doses: thirteen and twenty-two applications of 5 watts for five minutes, eleven and twenty-one applications of 10 watts for five minutes, and five and ten applications of 10 watts for ten minutes.

Slipping (displacement) of the upper tibial epiphysis (fig. 4) resulted in 8 rabbits, but was not observed in any of the dogs. This slipping of the upper tibial epiphysis was seen in 1 rabbit which received twelve applications of 5

Fig. 4a. — Anteroposterior view of the left knee of a rabbit exposed to six applications of 10 watts of ultrasound for five minutes. There are complete separation and displacement of the upper tibial epiphysis and dislocation of the knee. b. Anteroposterior view of the right, or control, leg. c and d. Lateral views of the knees shown in a and b, respectively. All roentgenograms were made eleven weeks after the first (nine weeks and two days after the last) ultrasonic application.

watts for five minutes. The other 7 rabbits experiencing this change were represented by the following doses: six and nine applications of 10 watts for five minutes (3 received six applications and 1 nine applications) and six and thirteen applications of 10 watts for ten minutes (2 received six applications and 1 received thirteen applications). Three of the rabbits showed widening of the upper tibial epiphyseal line prior to the slipping of the epiphysis.

Premature closure of the left upper tibial epiphysis was observed in 4 rabbits and 5 dogs (fig. 5). Three of the 4 rabbits received 5 watts for five minutes, 1 receiving six, another nine and another twelve applications; the fourth rabbit received nine applications of 10 watts for five minutes. Of 5 dogs, 2 received 5 watts for five minutes (1 received one application and the other thirteen), 2 received 10 watts for five minutes (1 received eleven and the other twenty-one applications), and 1 received five applications of 10 watts for ten minutes. Four of these 5 dogs and 2 of the rabbits previously had shown widening of the upper epiphyseal line prior to the development of premature closure of the epiphysis.

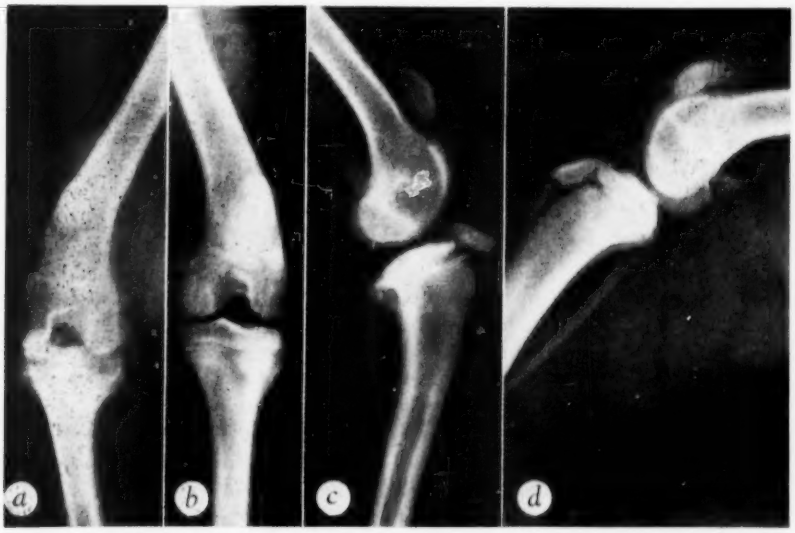

Fig. 5a. — Anteroposterior view of the left knee of a dog exposed to one application of 5 watts of ultrasound for five minutes. A small sclerotic upper tibial epiphysis, premature closure of the upper tibial epiphyseal line, and erosion of the medial tibial plateau are evident. b. Anteroposterior view of the right, or control, leg. c and d. Lateral views of the knees shown in a and b, respectively. All roentgenograms were made eighteen weeks and six days after the single ultrasonic application.

Widening of the epiphyseal plate with subsequent premature closure was associated with lower doses of ultrasound while slipping (displacement) was associated with higher doses. Buchtala[2] explained this widening on the basis of stimulation of epiphyseal activity by ultrasound. In view of the development of this widening of the upper tibial epiphyseal line, the premature closure of the epiphysis, slipping of the upper tibial epiphysis and the failure of any animal in the entire series to show an increase in tibial length measured by a vernier caliper, it is believed that this widening was not an acceleration of epiphyseal activity as Buchtala thought but was the result of trauma to the epiphyseal cartilage. If damage was mild, widening was observed followed by premature closure of the epiphysis; whereas if damage was more severe, epiphyseal slipping resulted.

Sclerotic changes were observed in the upper tibial epiphysis in 13 rabbits and 6 dogs. The incidence of this finding was fairly uniform throughout all basic-dose groups and over a range of one to thirteen or more applications of ultrasound in each dose group in both dogs and rabbits.

That ultrasound was carried across the knee joint was shown by the fact that alterations were observed in the lower femoral epiphyseal line, femoral condyles and knee joint. Widening of the lower femoral epiphyseal line occurred in 3 rabbits. One of these rabbits received twelve applications of 5 watts for five minutes, another received eight applications of 10 watts for ten minutes, and the third received nine applications of 10 watts for ten minutes.

Slipping of the lower femoral epiphysis occurred after initial widening of the lower femoral epiphyseal line in the rabbit which received eight applications of 10 watts for ten minutes. Two other rabbits showed slipping of the lower femoral epiphysis. One of these animals received nine applications of 5 watts for five minutes and the other eight applications of 10 watts for ten minutes.

Premature closure of the lower femoral epiphyseal line occurred in 6 rabbits (2 in each basic-dose group). One rabbit receiving six and another receiving nine applications were in the group that was exposed to 5 watts for five minutes; 1 rabbit receiving six and another receiving twelve applications were in the group that was exposed to 10 watts for five minutes, and 2 rabbits each receiving six applications were in the group that was exposed to 10 watts of ultrasound for ten minutes. One dog which received five applications of 10 watts for ten minutes experienced this change.

Erosion of the femoral condyle was found in 10 rabbits and 6 dogs (fig. 6). The extent of the erosion was variable. One rabbit which received twelve applications of 5 watts for five minutes experienced complete loss of the medial femoral condyle, while 1 rabbit receiving twelve applications of 10 watts for five minutes and another receiving thirteen applications of 10 watts for ten minutes experienced erosive destructive changes only on the articular surfaces of the femoral condyles. Thus the changes observed in the femoral condyles varied from slight to severe in animals receiving similar doses. This is further evidence of the unpredictability of the degree of the response of bone to ultrasound.

Dislocation of the knee occurred in 9 rabbits and 2 dogs (fig. 6). None of these animals were in the group exposed to 5 watts for five minutes. The rabbits showing this change were represented by six, nine or twelve applications of 10 watts for five minutes and six, eight, nine or thirteen applications of 10 watts for ten minutes. Of the dogs showing this change 1 received eleven applications of 10 watts for five minutes, and the other received five applications of 10 watts for ten minutes. Dislocation of the knee was found to occur in animals that received higher doses of ultrasound that produced destructive effects on the ligamentous structures of the knee joint.

Edema about the knee joint occurred in 21 of the 29 rabbits. Eleven of the 21 rabbits were in the group exposed to 10 watts for ten minutes and represented six to thirteen applications of this basic dose. Seven of the rabbits were in the group exposed to 10 watts for five minutes and represented six to twelve applications of this dose, while 3 of the rabbits were in the group exposed to 5 watts for five minutes and likewise represented six to twelve applications of this dose. Two dogs from each of the three basic-dose groups experienced this change about the knee. The dogs in these groups received thirteen or twenty-two applications of 5 watts for five min-

utes, eleven or twenty-one applications of 10 watts for five minutes, and five or ten applications of 10 watts for ten minutes. The incidence of loss of range of motion at the knee joint paralleled the incidence of development of edema about the knee.

Burns developed on the lateral side of the leg at the point of exit of ultrasound in 3 dogs. The doses for these animals were as follows: twenty-one applications of 10 watts for five minutes, and five or ten applications of 10 watts for ten minutes. Burns also developed on the lateral side of the leg of 6 rabbits. These 6 animals represented nine applications of 5 watts for five minutes, twelve or thirteen applications of 10 watts for five minutes, and eight or thirteen applications of 10 watts for ten minutes. These burns were evidence of the destructive effect of ultrasound. When ultrasonic energy passes from one medium to another having a different acoustic impedance it may be reflected at this interface. When ultrasonic energy of the frequency used in this study passes from tissue to air there is almost a 100 per cent reflection of the sound waves back into the tissue. This reflection results in

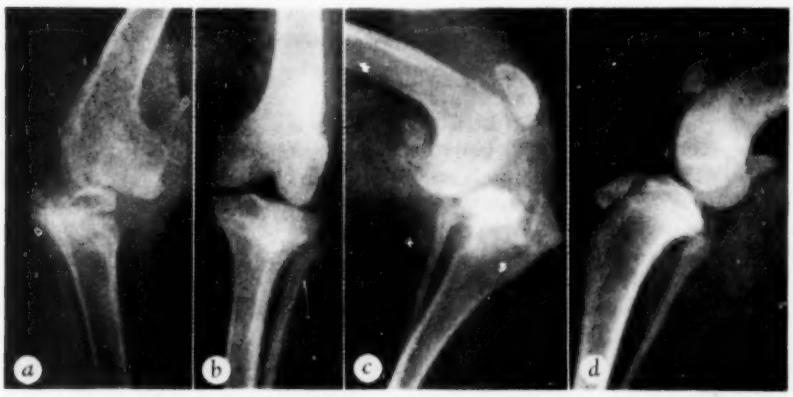

Fig. 6a. — Anteroposterior view of the left knee of a dog exposed to five applications of 10 watts of ultrasound for five minutes (exposures were given every other day for a total of four exposures, then three weeks later one more exposure was given). A region of bone resorption in the lateral part of the upper tibial epiphysis, erosion of the femoral condyles, sclerosis in the upper tibial diaphyseal region, and dislocation of the knee are evident. b. Anteroposterior view of the right, or control, leg. c and d. Lateral views of the knees shown in a and b, respectively. All roentgenograms were made thirteen weeks and two days after the first (nine weeks and two days after the last) ultrasonic application.

such a concentration of ultrasonic energy at the point of exit that second-degree burns develop. The fact that these burns were observed in so few animals, although many received doses similar to those for animals which did experience the burns, is not readily explained. It indicates the variability of response of tissues to ultrasound.

The lengths of the tibial and femoral bones of 9 of the dogs and 16 of the rabbits were measured with a vernier caliper. Comparison of the left tibial length to the right revealed no difference in 2 of the 16 rabbits but disclosed that the left tibia was shorter than the right in 14 rabbits. The range of this shortening was from 0.3 to 2.6 cm. Also in 10 of the 16 rabbits the left femur was 0.3 cm. or more shorter than the right.

The right and left tibias were of equal length in 3 dogs, while the left tibia was 0.3 cm. or more shorter than the right in 6 dogs. The range was from 0.3 to 2.4 cm. Also, in 5 of the 6 dogs the left femur was shorter than the right. In no case was the left tibia or femur longer than the right tibia or femur, respectively. In no case did femoral shortening occur without ac-

companying tibial shortening. Measurement of the lengths of the right and left tibias and femurs of dogs and rabbits which had not been exposed to ultrasound indicated that approximately 0.2 cm. was the greatest difference that could be expected when either the tibia or the femur was compared with the corresponding bone of the opposite side.

Because of variation in the animals' ages and differences in length of the observation period after exposure, it was impossible to correlate the degree of shortening with the size of ultrasonic dose applied. Buchtala's[3] contention that ultrasonic energy would accelerate growth of bone was not substantiated.

Since some type of damage to bone was observed in all the dogs, and since the minimal dose of ultrasonic energy for the dog was one application of 5 watts for five minutes, it appears likely that the minimal dose that will cause damage to tissue is even less than the minimal dose used in this study. Similarly, our study indicates that the minimal destructive dose for the rabbit is less than six applications of 5 watts for five minutes. The threshold value for damage to bone for the dog set by Barth and Bülow[4] (3.25 watts per square centimeter [16.25 total watts] for two minutes) is probably too high.

Summary and Conclusions

This experimental study was undertaken because of reports in the European literature concerning the widespread clinical use of ultrasonic energy and reports of the effects of ultrasound on the bones of animals. The upper tibial epiphyseal region of 9 dogs and 29 rabbits was exposed to ultrasonic energy. The three basic doses used were 5 watts of ultrasonic energy for five minutes, 10 watts for five minutes, and 10 watts for ten minutes. One of these basic doses was applied to each animal one or more times. The ultrasonic generator used had a frequency of 800,000 cycles per second and its quartz crystal was 2.5 cm. in diameter.

Changes in bone were observed by means of roentgenograms made prior to the first ultrasonic application and periodically thereafter. The lengths of the tibias and femurs of 9 dogs and 16 rabbits were determined by means of a vernier caliper; no increase in length of the exposed extremity was found in any of the animals. Bony alterations were not constant even among animals receiving similar doses. The reaction of the upper tibial epiphyseal region and adjacent structures in the dog and rabbit to ultrasound varied greatly. Changes in the bone as shown by periodic roentgenographic examination were: the development of areas of rarefaction in the upper tibial diaphyseal region, widening of the upper tibial epiphyseal line, slipping of the upper tibial epiphysis, fractures in the upper tibial diaphyseal region, widening of the lower femoral epiphyseal line, erosion of the femoral condyles, sclerotic changes in the upper tibial diaphyseal region and dislocation of the knee. Swelling of the region of the knee occurred in animals of all dose groups. Burns were observed on the lateral side of the leg at the site of exit of ultrasound in a number of animals. In general, these changes all were the result of destructive effects of ultrasound on the upper tibial epiphyseal region and adjacent structures of the dog and rabbit.

The results of this study on the effects of ultrasonic energy when applied to the upper tibial epiphyseal region of the dog and rabbit in the doses and manner described lead to the following conclusions:

1. Ultrasonic energy does not cause acceleration of the longitudinal growth of bone.

2. Ultrasound has a destructive effect on growing bone in the upper tibial epiphyseal region and adjacent structures of the knee joint.

3. The degree of destruction of growing bone caused by any given ultrasonic dose is unpredictable, as there is great variability of reaction to ultrasound.

4. Ultrasonic energy produces shortening of the tibia and femur but not without irreparable destructive effect upon the knee joint, the adjacent tibial and femoral epiphysis, epiphyseal cartilage and diaphysis.

5. Until safe doses are worked out through further experimental investigation, it is felt that ultrasonic therapy should not be applied to growing human bone.

EFFECT OF VARIOUS PROCEDURES ON THE FLOW OF LYMPH * †

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The flow of lymph and the various factors which affect it have been of particular interest to many investigators for more than a hundred years. Webb[1] recently stated: "The forces resulting in the propulsion of lymph remain clouded even today. At the present time little can be added to the conclusion of Sheldon that muscular power of the vessel, assisted by the collateral pressure produced by respiration and by adjacent muscles and arteries, will impel the fluid towards the heart." That massage and exercise produce marked increases in the flow of lymph is firmly established.[2-3] The effect of heat on the flow of lymph remains in a state of controversy in spite of excellent and extensive investigations by experts in this field of physiology.[4-5-6-7] Physicians who are particularly interested in the basic principles of physical

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† Read at the American Congress of Physical Medicine, Denver, Colorado, September 6, 1951.

‡ Now Secretary of the Council on Physical Medicine and Rehabilitation, A. M. A., Chicago.

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medicine would like to know whether or not the physical agents, as they are used for producing heat in various regions of the body, bring about significant changes in the flow of lymph.

This paper reports the results of a study in which we did not observe any significant alteration in the flow of lymph from the thoracic duct of the dog or rat during the application of heat, when the standard techniques of physical medicine were employed.

Procedures and Results

Study 1. — A series of 10 dogs ranging in weight from 15 to 23.5 kg. were trained to walk on a treadmill, to rest quietly on a Pavlov stand, to lie in a horizontal position on a particular type of table and to lie or stand with heads in a special cabinet for production of fever. After the training period was completed, cannulation of the thoracic duct was performed. The method of cannulation of the thoracic duct has been used in a number of studies in our laboratory and has been described in detail in another publication.[8] Briefly, the technique consists in the retrograde cannulation of the thoracic duct in the lower part of the thorax where it lies behind the descending aorta. Ether insufflation anesthesia and the usual aseptic surgical technique are used; the duct is exposed by means of a thoracotomy low on the left side. A length of small diameter, flexible, polyvinyl copolymer tubing* is used as the cannula. One end is inserted through an opening in the duct for several centimeters in a caudal direction, so that the tip lies in or just above the cisterna chyli. The other end is led out of the chest through a lateral stab wound. During the first twenty-four to thirty-six hours after operation, the time of greatest danger of obstruction of the cannula by clotting, the dog is given half normal saline solution for drinking water and, in addition, 10 cc. of saline solution per kilogram of body weight every twelve hours by hypodermoclysis. By this method a continuous flow of lymph, consisting of virtually all the lymph from below the diaphragm (from abdominal viscera and hindquarters) of the animals was obtained for several days to a week. Infrared irradiation, short wave diathermy, microwave diathermy and the fever cabinet were used as sources of heat. The techniques developed for the clinical application of these heating agents were used in each procedure except when the fever cabinet was employed. The hair of the hindquarters of the dog was clipped closely before any of the agents producing heat was applied. Lamps equipped with 250 watt Mazda bulbs with the usual bowl reflectors were used as the source of infrared rays. These were placed at a distance of 12 inches (30.5 cm.) from both thighs. The induction cable of the short wave apparatus was used. The cable, with proper air spacing, was wrapped around both thighs and looped over the back. The microwave diathermy was applied to both thighs with the microwave director 2 inches (5.1 cm.) from the skin and the output was either 65 or 93.5 watts. The fever cabinet consisted of a humidified heated chamber placed over the dog's head.[9] In most instances the heating periods were thirty minutes. The lymph was collected continuously after operation. After satisfactory control data were obtained, the different heating agents were applied for various periods. Observations were continued for variable periods after removal of the heating agent. The flow of lymph was measured directly by collection in a graduated tube for a known interval

8. Grindlay, J. H.; Cain, J. C.; Bollman, J. L., and Mann, F. C.: Lymph Fistulas in Trained Dogs. An Experimental Technique, Surgery 27:152 (Jan.) 1950.

* The tubing used in this study was "Transflex" tubing, size 20, and was kindly furnished by the Irving Varnish & Insulator Co., Irvington, N. J.

9. Bennett, R. L., and Elkins, E. C.: Laboratory Method for Production of Fever, Arch. Phys. Therapy, 21:216 (Apr.) 1940.

of time. Because the heating effects of the various agents used are well known, it was not considered necessary to determine temperature except in special cases.

The results of our preliminary study on the dog demonstrated clearly that the factor of exercise was masking the effect of heat. Except when the dog was unusually quiet, it was necessary to resort to anesthesia in order to observe the effects of heat alone. We found then, that heat as applied in our investigations causes no significant change in the flow of lymph. It was decided, therefore, to introduce the factor of exercise and massage as a control procedure in order to prove that an increase in flow of lymph could take place if heat per se augments the flow. Both passive and active exercises were employed.

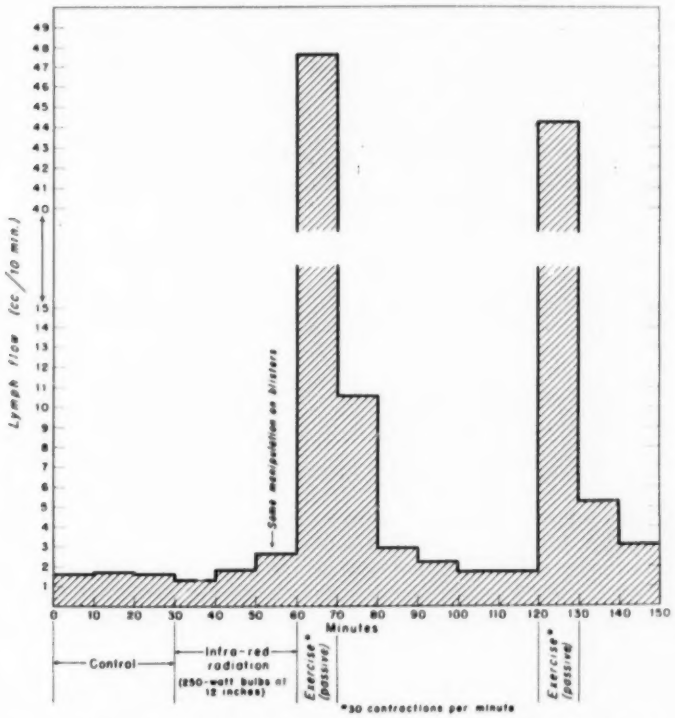

Fig. 1. — Effect of infrared irradiation on the flow of lymph from the thoracic duct of the anesthetized dog. Effect of passive exercise also indicated.

In the anesthetized dog infrared rays produced no significant increase in the flow of lymph, whereas in the same anesthetized dog passive exercise (rhythmic pumping of the leg) produced a marked increase (fig. 1). Pumping* of the leg of the unanesthetized dog was not considered passive because there was always mild muscular resistance (figs. 2 and 3). Active exercise, consisting of raising and lowering one or both hind legs rhythmically, produced marked increases in flow, as did exercise on the treadmill (fig. 4). Frequently when the lymph was milky during the control observations it would become clear during exercise and then return to the milky appearance

* Rhythmical contractions of hind leg.

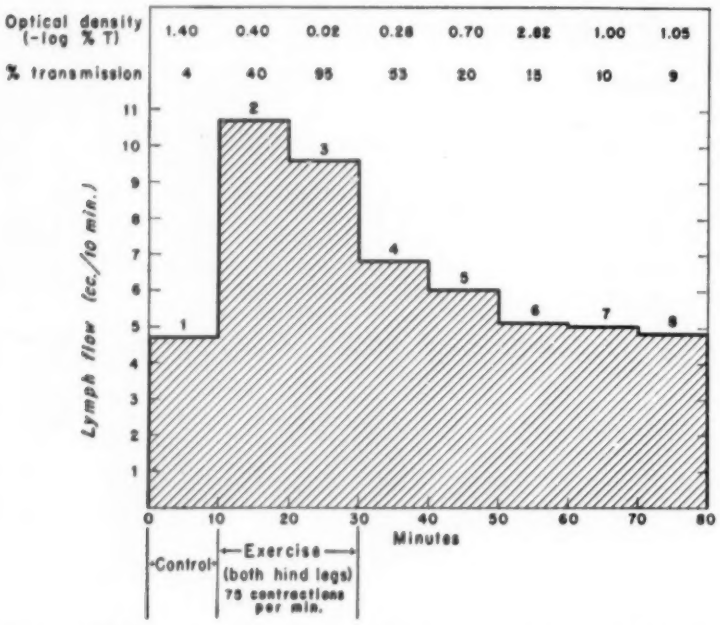

Fig. 2. — Effect of exercise on the flow of lymph from the thoracic duct of the dog. The optical density and percentage transmission of each collection is indicated. The number of each collection appears on the graph. The samples collected are shown in figure 3.

following the exercise (fig. 3). Microwave diathermy (fig. 5) and short wave diathermy (fig. 6) caused no significant change in the flow of lymph. In some of the dogs on about the fifth or sixth day after cannulation, edema developed in the legs owing to loss of protein in the lymph (hypoproteinemia). Advantage of this situation was taken by observing the effect of kneading and stroking massage on the flow of lymph of the edematous hind leg and thigh. The massage consisted of a combination of centripetal kneading and stroking. The number of strokes per minute for each type of massage used was about equal. There was a marked increase in flow of lymph on repeated massaging of the edematous legs (fig. 7). Reduction in size was demonstrated

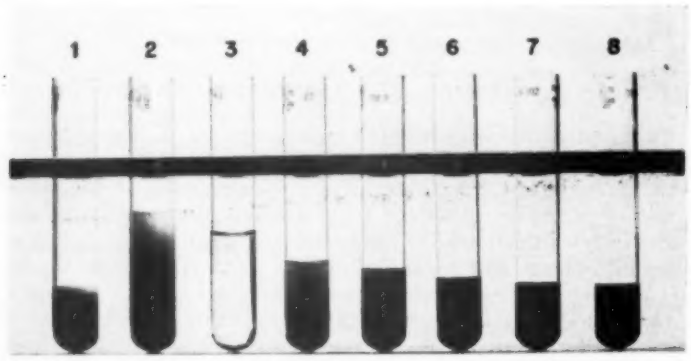

Fig. 3. — Lymph collected at various intervals indicated in figure 2. Sample 3 is clear lymph.

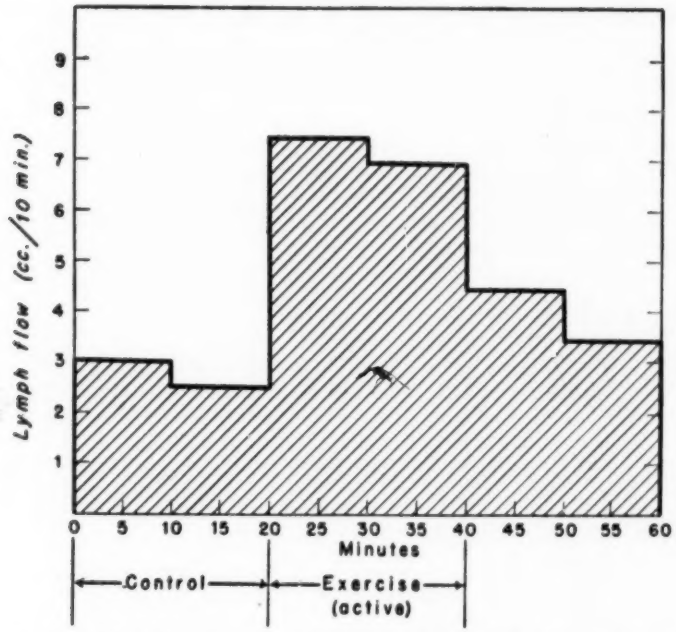

Fig. 4. — Effect of exercise (on treadmill) on the flow of lymph from the thoracic duct of the dog.

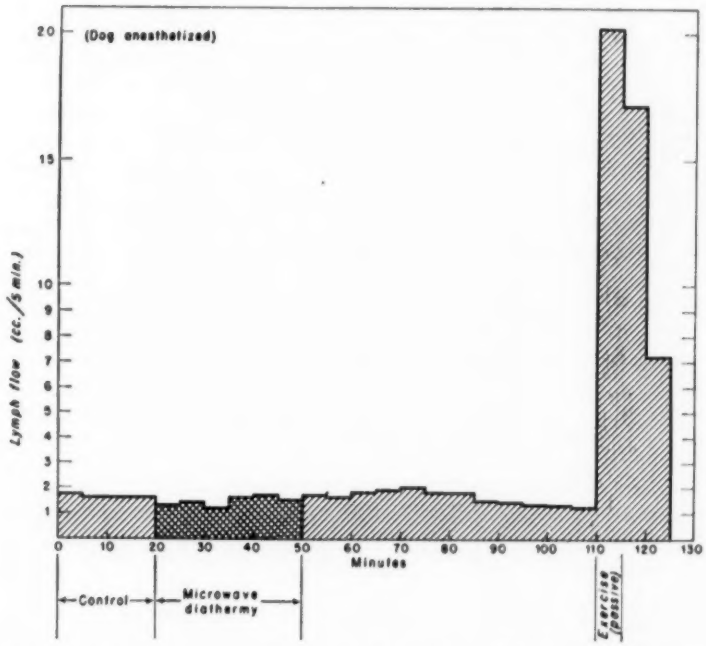

Fig. 5. — Effect of microwave diathermy on the flow of lymph from the thoracic duct of the anesthetized dog. Effect of passive exercise also indicated.

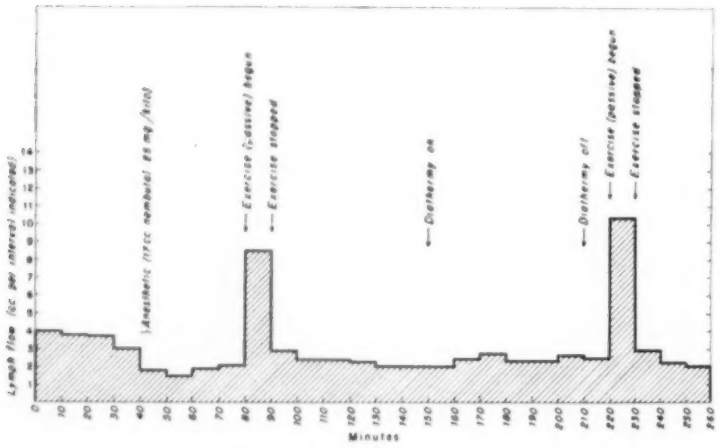

Fig. 6. — Effect of short wave diathermy on the flow of lymph from the thoracic duct of the anesthetized dog. Effect of passive exercise also indicated.

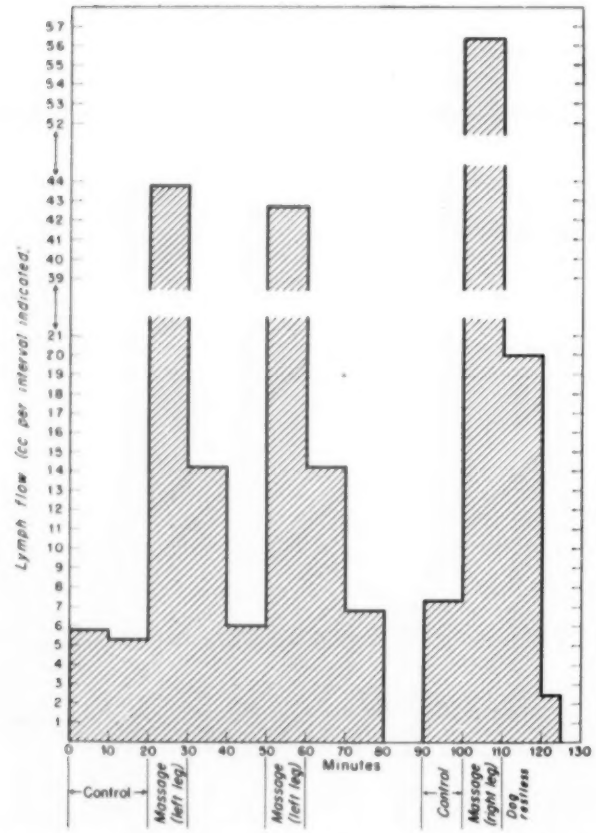

Fig. 7. — Effect of massage of edematous legs on the flow of lymph from the thoracic duct of the dog.

by actual measurement of the extremity following the massage. One of the dogs died during the induction of anesthesia. This gave opportunity for observation of postmortem flow of lymph in the thoracic duct. Data were collected on the effect of passive exercise of the hind limbs, following the death of this dog. The flow of lymph continued for at least forty-five minutes and was about as great following manipulation of the leg as it was following the same type of exercise when the dog was living (fig. 8). Similar observations have been made by previous investigators.[10] Hyperpyrexia could not be produced in the dog by means of the fever cabinet without great restlessness on the part of the animal; thus the effect of exercise could not be ruled out. Therefore, this particular study was abandoned.

Study 2. — Male albino rats of the Sprague-Dawley strain were used in this study. The weight of the rats ranged from 180 to 250 gm. The thoracic duct was cannulated with flexible polyethylene tubing according to a procedure previously described in the literature.[11] The rats were placed in small cages,[12] which prevented them from turning around and in which they rested quietly and comfortably. The lymph was collected continuously. About two hours before control observations on lymph flow were begun, each rat was given a standard meal by stomach tube. All rats were allowed to drink water freely until the study was started. During each period of study the rats were given 3 cc. of saline solution subcutaneously every hour. Only one type of heating, microwave diathermy, was used for rats. Hyperthermia was produced in each experiment. Lymph flow and rectal temperatures were observed. After control observations of one hour or more the microwaves were directed at the lateral aspect of the body of the rat. The distance of the microwave director (antenna) from the rat was 5 cm. and the output of the microwave generator was kept at approximately 37.5 watts until the desired rectal temperature was attained. The desired rectal temperature could be maintained thereafter by careful control of the output of the microwave generator. All temperatures were measured with thermistor thermometers.[13] During exposure of the rat to microwaves it was necessary to turn off the microwave generator and wait for about fifteen seconds before the rectal temperature was read. Temperature was recorded every five minutes throughout each experiment.

It was found that hyperthermia did not cause any increase in the flow of lymph from the thoracic duct of the rat. Moderate increases in body temperature were not accompanied by any significant change in flow of lymph. When the body temperature rose to more than 41 C., there appeared to be a small decrease in the flow of lymph. It was found that the rats would die if a body temperature of 42 C. was maintained for more than a short period. As the body temperature returned to the control value, the flow of lymph also returned to control levels (fig. 9)

Summary and Conclusions

No significant changes in flow of lymph from the thoracic duct of the dog were observed when the heating agents, infrared, short wave diathermy or microwave diathermy, were applied. It was possible, however, to demonstrate marked increases in the flow by exercise. Kneading and stroke massage also cause marked increases in flow. Passive exercise brought about

10. Rouviere, H., and Valette, G.: Quoted by Drinker, C. K., and Yoffey, J. M.[2]
11. Bollman, J. L.; Cain, J. C., and Grindlay, J. H.: Techniques for Collection of Lymph From Liver, Small Intestine, or Thoracic Duct of Rat, J. Lab. & Clin. Med. **33**:1349 (Oct.) 1948.
12. Bollman, J. L.: Cage Which Limits Activity of Rats, J. Lab. & Clin. Med. **33**:1348 (Oct.) 1948.
13. Herrick, J. F., and Glarborg, E. A.: Application of Thermistors to Temperature Measurements in Experimental Animals, Proc. Minnesota Acad. Sc. **17**:87, 1949.

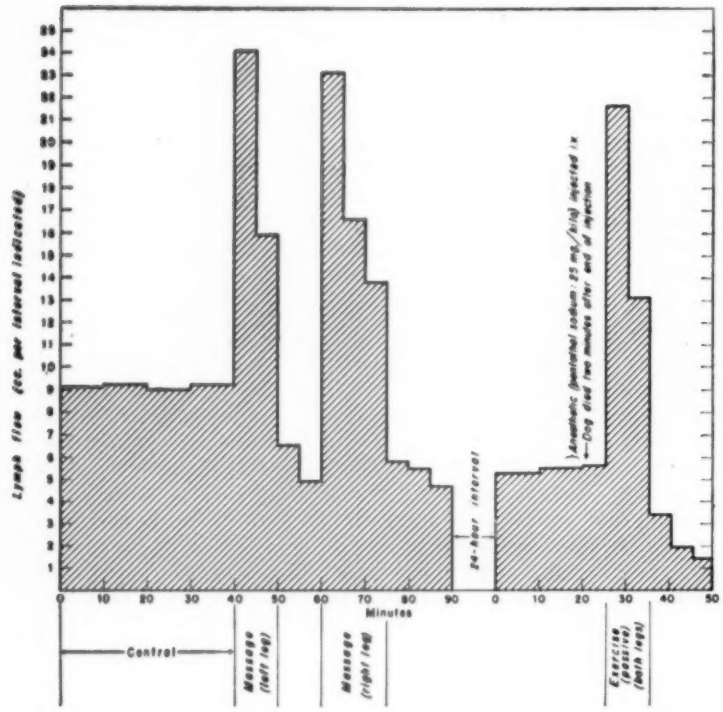

Fig. 8. — Observations on the flow of lymph from the thoracic duct of the dog before and immediately following death.

increases in flow of lymph as great as twenty-five fold. In dogs in which edema of the legs had developed owing to loss of protein through loss of lymph, kneading and stroking massage caused marked increases in flow of

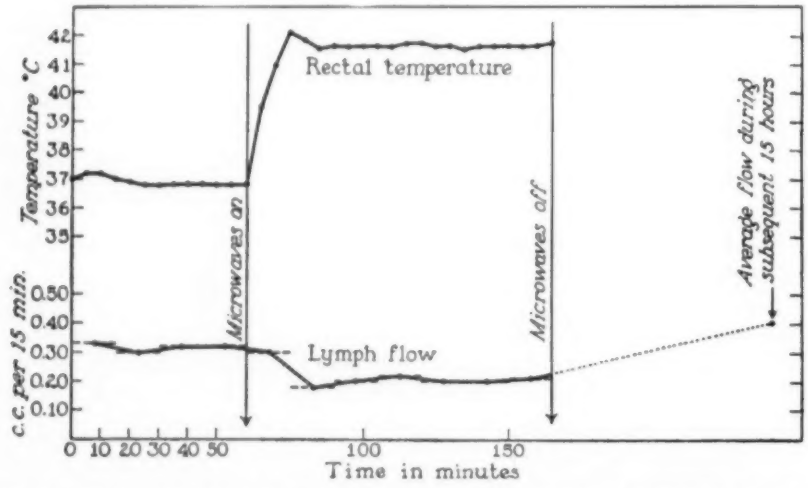

Fig. 9. — Observations on lymph flow and rectal temperature before and during hyperthermia in the rat.

lymph with apparent decreases in the extent of edema. The same marked increases in flow of lymph due to exercise were demonstrated immediately after death, as before death. The flow of lymph from the thoracic duct of the rat does not increase and in some instances even seems to decrease during hyperthermia.

Acknowledgments. — We wish to express our appreciation to Mr. Emory Van Hook and to Mr. Glenn Christensen for valuable technical assistance during this study. Mr. Van Hook performed the operative procedures necessary for the collection of lymph from the rat. Mr. Christensen was responsible for the training and meticulous care of the animals, so important for the success of our experiments. We wish also to express our gratitude to Dr. Frank D. Mann for making the transmission measurements on collected samples of lymph.

Discussion

Dr. William D. Paul (Iowa City:) The authors are to be congratulated on their interesting paper. Although the circulation of blood has been investigated many times, few people have concerned themselves with the factors influencing lymph flow. Starling as early as 1894 studied the effect of heat on the flow of lymph. He immersed a dog's foot in warm water (60 C.) for five minutes and found an increase in flow of lymph with an increase in the protein content. Barcroft and Kato in 1915, found that when a skeletal muscle was stimulated rhythmically for 15 minutes, fluid left the muscle and the muscle increased in weight. They did not, nor has anyone, actually determined the amounts of lymph formed; but there can be no doubt that lymph production increases under circumstances of increased filtration from the blood capillaries, as in muscular work. Landis and his co-workers (1933) found that increasing heat of the forearm increased the filtration rate from capillaries. They found that lymph flow became active, when temperature of the part reached 50 C. Temperatures of this magnitude may cause denaturization of protein. These results were confirmed by Fuld, Drinker and White (1933). Drinker found that in a resting animal it is possible to massage a foot and obtain a small amount of lymph. The flow is greatest when pressure is first applied and then falls off rapidly, so that if massage is continuous a time is soon reached when practically no lymph is secured. If at this point massage ceases and there is a rest of 10 to 30 minutes, lymph can again be obtained.

Whenever experiments are carried out in animals the effect of the anesthesia must be taken into consideration. In the dog, thoracic lymph flow depends upon the type of anesthesic agent employed. When morphine-ether combinations are used, the flow of lymph averages about 7.0cc./10 min. After sodium barbital the rate drops to 4.3cc/10 min., while curare will give a rate of 6.4cc./10 min.

It must be emphasized that collection of lymph from the thoracic duct does not represent flow through any one area. Results obtained from such a place are apt to be confusing. To measure the effect of muscle activity, massage or heat, collections of lymph should be made from the lymph vessels draining the part that is being studied. The work reported in this paper once again substantiates the observations made by Drinker and his co-workers in the 20's and 30's.

Two questions might be raised first, was the protein content of the lymph studied? Secondly, were the cellular elements of the thoracic lymph determined?

REHABILITATION OF 120 LOBOTOMIZED PATIENTS IN A VA HOSPITAL *

CHAS. H. REAGAN, M.D.

TUSCALOOSA, ALA.

Eighty-eight years after the Phineas Gage incident, a brain operation involving destruction of the anterior portion of the frontal lobe was described by Egas Moniz of Lisbon, Portugal (1936) in the treatment of psychosis. This operation was quickly adopted and modified in this country by Freeman and Watts, who still use this "closed" method. The following year, Lyerly did the first "open" operation.[1] The operation has become so widespread that the public press notes that 10,000 lobotomies have been performed in the United States in the past 16 years. Our report includes 120 patients operated on over a period of four years (1947-1952). All operations have been by the "open" technique preferred by Lyerle, Poppen and Penfield, using a bilateral approach and performed by one neurosurgeon, Dr. James G. Galbraith of Birmingham, Alabama.

Our hospital has been fortunate in having less than a 1 per cent post-operative convulsive rate in contrast to the general average of 10 to 30 per cent. We have operated on one patient for severe hypochondriasis, one for manic depressive psychosis, two for the relief of intractable pain, one for unrelenting conversion-hysteria with the production of disabling physical symptoms, and three with involutional melancholia. All of these patients have had good results. The remaining 111 were schizophrenics, with several cases of affective disorders. Forty-four were hebephrenic, 30 catatonic, 27 paranoid, 8 unclassified and 2 mixed type. Every patient is studied on the basis of his individual illness. In deciding whether or not to operate, the degree of "tortured self-concern" is a primary factor. How does the patient live with his delusional material? Has he become completely leveled emotionally, or does he react violently to his psychotic material? Those patients who demonstrate terrific degrees of tension are generally considered good potential material. There are other factors which have to be taken into consideration, namely, the duration of the illness, the nature of the onset of the illness, was it insidious or was it abrupt, and the response of the patient to the other forms of therapy, such as electro-shock or deep insulin therapy. Open combativeness or hyperactivity is not necessarily the only indication of degree of affect remaining, in that we have had several patients whose terrific hostility was not thus openly exhibited.

Patients are selected for surgery at a conference of the Special Lobotomy Board, which meets bi-weekly and consists of the following personnel: (1) Presenting Physician; (2) Chief, Intensive Treatment Division; (3) Psychiatrist; (4) Chief, Medical Service; (5) Chief Psychologist; (6) Neurosurgeon; (7) Area Chief, Neuropsychiatric Division. (Further details may be found in TB-10-504, V. A. Technical Bulletin.)

Following surgery, planning for the patient is in the hands of a coordinated team known as the Post Lobotomy Board, composed of the following personnel: (1) Chief, Intensive Treatment Division; (2) Chief, Physical Medicine Rehabilitation and Staff; (3) Social Worker; (4) Psychologist;

* Chief, Physical Medicine and Rehabilitation Service, Veterans Hospital, Tuscaloosa, Alabama.

1. Greenblatt, M.; Arnot, R., and Solomon, H. C.: Studies in Lobotomy. Grune and Stratton, N. Y., 1950.

(5) Nursing Service; (6) Aides. This board meets bi-weekly for the purpose of exchanging information and experiences acquired in working with the patients. This is done to individualize the treatment program within the framework of the total program.

Practically all of our 120 cases were schizophrenics, threatened with life-long disability or suicide, on whom other treatments failed to give any promise of success. The primary goal is to enable these individuals to live outside of an institution in their own communities, where they may become useful citizens. Those able to be gainfully employed may be limited in their earning powers, but this may represent the difference between a taxeater and a taxpayer and can mean a great deal to the morale of the patient and his family.[2]

Although there are those who can see little value in an intensive rehabilitation program following such operation, most workers are in agreement that the operation itself, no matter what technique is used, is seldom a complete treatment.[1] The procedure relieves emotionally painful tensions and fears, and makes possible the re-establishment of more normal and socially acceptable thought patterns.[3] It is reasonable to assume that since the patient shows less resistance to socializing efforts, such re-education should be attempted. There seems to be general agreement in the literature that the operation relieves incapacitating symptoms by severing undesirable paths of association.[2] If so, our job is to help re-establish desirable ones.

This is attempted through a program of educational therapy, corrective exercises, occupational therapy and recreational activities. All our therapists are informed before a patient is operated on so they can familiarize themselves with the case history. Chances are they already know the patient very well from contacts during their hospital stay.

It is realized that rehabilitation continues from two to five years, post-operatively.[1] What we try to do is to initiate the process — start it in the right direction and enlist the cooperation of relatives to continue it. For those who recover sufficiently, relatives will have to carry on in the home for a long period of time. Those who must remain hospitalized after "total push" is over, are not forgotten. Special consideration is given to their integration into the continued treatment program and their progress is noted periodically by the Post Lobotomy Board at the bi-weekly meetings. All activities are carried on daily. A master schedule is agreed upon by this board and followed by the aide in charge.

About the fifth post-operative day, the patient is taken by the special aide assigned to the lobotomy rehabilitation team. There are usually from three to eight patients in this group and they are always treated as individuals. One of the earliest activities is long walks with the corrective therapist. Here is an effective modality for establishing rapport, normal response to bodily fatigue, and contact with outside environment. Mat exercises involving bodily contact with the therapist are used. The patient progresses to individual exercises with the stationary bicycle, punching bag, etc., then to dual, competitive games with the therapist and other patients, such as table tennis, and finally group cooperation is added in such games as volley-ball. If progress does not develop naturally, an effort is made to motivate and stimulate the patient to the point of individual tolerance. Toilet training, proper dress and posture, and personal cleanliness are constantly taught. Re-

2. Cobb, Stanley: Borderlands of Psychiatry. Cambridge, Mass., Harvard University Press, 1944.
3. Rackow, Leon L., and McGriff, Dorothy L.: Rehabilitation of the Prefrontal Lobotomy Patient, J. Occup. Therapy & Rehab. **29**:329, 1950.

sponsibility for this phase of training is shared by the special attendants, the nurses and all members of the medical rehabilitation service.

In educational therapy an attempt is made to provide new interests, create a sense of worthwhile accomplishment and establish goals for the patient to achieve. An opportunity is made for development of new and desirable habit patterns based on the successful completion of numerous lesson units, each of which represents a separate goal, thereby increasing the patient's confidence in himself and his ability to solve larger problems. Patients are taught to cooperate with each other in the solution of problems as a phase of re-socialization. Educational motion pictures are used to aid in the recognition and recall of familiar scenes and to broaden the horizon of the patient. These movies serve as motivation for later discussion and as a means of roughly determining the development of powers of observation. Some elementary form of art work usually initiates the patient into occupational therapy. Early group activity consists in making one small part of an artificial flower, or participating in work supplied by the hospital, such as shelling peas for the dietetic department. Individual therapy is geared to the patient's personal requirements, progress, educational level and ability. Patients respond to occupational therapy better when they realize that their project is to serve a useful purpose, as when they make colorful decorations for use at hospital entertainments. Progress here is toward the more skilled crafts in order to provide an opportunity for creative accomplishments and to furnish means for acceptable expression of aggressiveness or irritability. Span of interest in these activities is short at first and changes in pace are made to fit the needs of the individual patient. Childlike behavior, lack of initiative and procrastination are dealt with by constant encouragement.

Home Care

Families should be chosen as carefully as patients in this type of operation,[3] and, in our series, lobotomy was performed only when the family wanted it to be done or readily accepted an explanation of its possible value and results. A satisfactory family situation is of major importance for successful post-operative social adjustment. It is imperative that considerable family preparation should be made before the patient is released from the hospital. Whenever possible, members of the family are interviewed in order to prepare them to accept changes in the personality picture and to investigate the home situation with a view toward a future home visit.

A guide, "Home Care Following Lobotomy," has been prepared by our Social Service Department on methods to use in continuing the rehabilitation process in the home. This guide is discussed with the family in detail and a copy is presented to them. The material, written in the form of a catechism of 37 items, points out actions or traits that may be exhibited by the patient and the specific methods that the family may use to redirect or change each action. The two important fundamentals stressed in the home care guide are: "(1) You will need a great deal of patience in working with him. (2) He will need to be kept constantly busy."

The family is encouraged to ventilate any feelings of anxiety or guilt that they may have concerning the patient's return home and are encouraged to raise questions in regard to the patient's care during his stay at home. Frequent studies by social workers in the home community are made and the patient's family is urged to return to the hospital for further consultation with our staff, if they feel it necessary. On occasions the patient also returns for individual interviews if he or the family wishes.

The family is taught that the patient is in an emotional childhood from which growth and maturity may be hopefully expected in due course of time with constant training and guidance. An important asset is the fact that intelligence usually remains intact.[4] It is necessary to maintain rigid control over money and property handled by the patients because they are easy marks for unscrupulous sharpies. Although emotional tensions are decreased by the operation, it is found that excessive use of alcohol may become a problem so that abstinence is desirable.

Return to gainful employment is usually consistent with a fairly acceptable type of adjustment. By this time, the inertia has disappeared and the various social amenities, which enable one to move comfortably among one's fellow men, have been sufficiently well established for the achievement of a more effective attitude toward life.

Results

Of the 120 patients lobotomized there was no immediate mortality. Twenty have been so recent that evaluation of results is far from complete. Two were operated on as lately as April 16, 1952. However, 10 of them are on trial visit now, and one of these discharged and declared competent.

Of the first 100 we have this to report: Forty-seven are in the hospital, six on trial visit, three died while still in the hospital (two to fourteen months post-operatively), three transferred to other hospitals, and 41 were discharged from the hospital. Twenty-nine of the 47 in the hospital now have been on trial visit and eleven of them actually discharged, but later re-admitted. About one-third of all those returning to the hospital from trial visit have done so because of environmental conditions.

Social Service has been able to get complete reports on 21 of the 41 discharged. One died seven months after discharge, three are partly employed, six in training and eleven fully employed.

In this report five patients were operated on twice and each time reported as a separate case in the results, making 120 operative cases on 115 different patients.

With only 120 cases, conclusions are not warranted, especially in the absence of a control group of any kind. But is it not reasonable to assume that most of these 41 discharged patients would still be costing us $13.17 each per day if they had not received benefit of this operation and the rehabilitation program?

Discussion

Dr. Jack Meislin (Montrose, N. Y.): Almost half a century before Moniz, Dr. Burckhardt performed several operations which would be now called lobotomies. However, that Swiss psychiatrist had to give up this approach because of the criticism of the nature of the procedure by the public and his medical contemporaries.

Treatment by psychosurgery is unique because its very therapeutic value lies in the fact that a deficit is voluntarily produced in depriving a patient, irreversibly, of something which we consider the essence of our individuality. Laymen frequently refer to this entity as the "soul." It is not unusual to hear a remark, such as "She is with me in body but her soul is in some way lost." More scientifically this result of the operation has been described as "bleaching of emotional responses," where the "social self" is affected. Lobotomy is a procedure of "therapeutic desperation" which merely points to the helplessness of present day medicine in its attempts to deal with the severely ill mental patients who have not responded to the usual psychiatric methods. Nevertheless, this procedure is capable of restoring "dignity" to many of our patients in addition to relieving that "tortured self concern" mentioned by Dr. Reagan. Others, who, long ago, were given up "for dead," even by those devoted to them, were reunited with their loved ones — for a price, which the latter are willing to pay — and this is our moral justification for performing these operations.

The rehabilitation of the lobotomized

4. Freeman, Walter, and Watts, James W.: Prefrontal Lobotomy — Convalescent Care and Aid to Rehabilitation, Am. J. Psychiat. 99:318 (May) 1943.

patients is real rehabilitation. These individuals, more so than others, go through a second early formative development. It is particularly important to guide them at this period in the establishment of proper behavior and work patterns by such means as Dr. Reagan comprehensively described. I applaud Dr. Reagan's emphasis upon the importance which the patient's family plays in the staff's deliberations. To me a "total approach" is more than treating the patient "as a whole," as an individual — it also implies consideration of the effect of our management of that patient on his family, community, and even society. I should also like to emphasize the importance of having a post-lobotomy board, as described by Dr. Reagan, although I wonder whether the omission of the ward physician from that board is not a typographical error.

The question frequently arises whether the lobotomized patients should be treated as a group and whether they should be sent home as soon as possible or after a few months of hospital supervision. This decision should be made in the light of such considerations as: what kind of hospital activity program exists, how understanding are the relatives, and so on.

Considering the severity of the patients' illness in this series of cases, the results that Dr. Reagan reports are very gratifying. However, there is one phase which should be of concern to us: the fairly large number of patients returning to the hospital. Social considerations play an important role here, but there is also something else: to what extent was vocational maladjustment or fear of such maladjustment responsible for this? The satisfaction which these individuals derive from a financial reward was described by Freeman and Watts. But most of these patients do not have the emotional tolerance to function on an eight hour schedule as demanded by our society. The Committee on Correlation of Physical Medicine and Psychiatry has strongly stressed the need of Psychiatric Sheltered Workshops where the patient could earn in proportion to his tolerance. This need becomes particularly obvious in reference to the lobotomized patients — society owes these individuals a special debt.

Dr. Reagan is to be commended for having presented a comprehensive evaluation of a therapeutic approach to the seriously ill psychiatric patients where a vigorous rehabilitation program plays such an important role.

31st Annual Session

SCIENTIFIC EXHIBIT SPACE

Requests for applications for scientific exhibit space in connection with the 31st Annual Session to be held at The Palmer House, Chicago, August 31 through September 4, 1953, are being received. Address all communications to the American Congress of Physical Medicine and Rehabilitation, 30 North Michigan Avenue, Chicago 2, Illinois.

ARCHIVES of PHYSICAL MEDICINE and REHABILITATION

Official Publication
AMERICAN CONGRESS OF PHYSICAL MEDICINE AND REHABILITATION
AMERICAN SOCIETY OF PHYSICAL MEDICINE AND REHABILITATION

.·. EDITORIAL .·.

AMERICAN BOARD OF PHYSICAL MEDICINE AND REHABILITATION

The next examinations for the American Board of Physical Medicine and Rehabilitation will be held in New York, May 30 and 31, 1953. The final date for filing applications is March 31, 1953. Applications for eligibility to the examinations should be mailed to the Secretary, Dr. Robert L. Bennett, 30 North Michigan Avenue, Chicago 2, Illinois.

MICROWAVE DIATHERMY IN OPHTHALMOLOGY

For some time it has been apparent that because of its unusual properties, microwave diathermy might be very effective in heating the eye provided suitable doses could be determined. Two pertinent articles and certain discussions in the *Transactions* of the American Academy of Ophthalmology and Otolaryngology[1] suggest safe clinical doses and give a number of indications for the employment of microwave diathermy in ophthalmology. Thorpe recommends a wattage of 20 per cent of the output of the standard microwave diathermy apparatus employing director "C" (the corner director) with the director at a distance of 2-3 inches from the skin and maximal time of exposure 20 minutes, suggesting employment of microwave diathermy in iritis, cyclitis, scleritis, keratitis and inflammatory conditions of lids and orbit.

Clark[2] recommends an output of 20 to 30 per cent employing the "C" director at a distance of 3 inches from the skin for 10 to 15 minutes, either daily or three times a week, listing as indications senile macular degeneration, retrobulbar neuritis, central serous retinopathy, thrombosis of the central retinal vein, traumatic hemorrhage and postoperative uveitis.

In discussion of these two papers, R. H. Davies of Detroit mentioned that experimentally using 75 per cent output with the director 3 inches from the skin for twenty minutes, the average increase in temperature of the vitreous was 2.5 C., that of the retrobulbar tissue was 1 C. and that of the aqueous was 2.4 C. Dr. Graham Clark of the Presbyterian Hospital in New York stated that to produce even higher temperatures a standard dose was given with 60 per cent of the output using director "C" applied every other day for twenty minutes at each treatment, the distance being 4 inches from the closed eyelid.

1. Thorpe, H. E.: Microwave diathermy in ophthalmology, the various diathermy currents used in ophthalmology. Tr. Am. Acad. Opth. 56:596 (July-August) 1952.
2. Clark, W. B.: Microwave diathermy in ophthalmology, clinical evaluation. ibid. p. 600.

None of these observers found that such doses produced any damage to the crystalline lens. Thorpe thought that the employment of microwave diathermy at high wattages might be dangerous but that dosages which he employed appeared "for the present to be a safe procedure, avoiding overheating of delicate ocular structures and undesirable sequelae." Clark said that with his method, which utilizes 20 per cent of the output for 15 minutes at a time, he had "never observed any damage to the crystalline lens" although many of his patients received a "very large number of treatments." Davies said that he was certain that "no harm was done in any case" in his series, and Graham Clark stated that even when he used 60 per cent output at a distance of 4 inches for twenty minutes employing director "C," there was "no damage shown in any ocular tissue in any of the animals immediately, at three months or six months thereafter."

William Clark has stressed the point that "The obvious advantage of microwave therapy is that with it, it is possible to heat the deeper tissues without undue heating of the more superficial tissues."

Specialists in physical medicine should give further consideration to the employment of microwave diathermy in carefully applied safe dosages in collaboration with ophthalmologists in the management of some of the diseases listed by Thorpe and by William Clark. Dosage must be very carefully controlled. However, it is apparent that ophthalmologists have developed safe doses for clinical use and have found a number of indications for the employment of this new type of high frequency radiation.

A NEW NAME FOR THE ARCHIVES

With this issue in conformity with the change of the name of the American Congress of Physical Medicine to the American Congress of Physical Medicine and Rehabilitation, the *Archives of Physical Medicine* also changes its name to the *Archives of Physical Medicine and Rehabilitation*. This is a timely change. A uniform terminology is now being followed by the various organizations in the United States which deal with our particular discipline. The society of specialists in this branch of medicine is now known as the American Society of Physical Medicine and Rehabilitation, the Council of the American Medical Association dealing with the selection of apparatus in this field of practice, with problems of education and other similar subjects is now known as the Council on Physical Medicine and Rehabilitation. The section in the American Medical Association dealing with this phase of medical practice is known as the Section on Physical Medicine and Rehabilitation and the specialty board which qualifies physicians in this discipline is known as the American Board of Physical Medicine and Rehabilitation.

It is gratifying, therefore, finally to announce the change of name of the *Archives* to conform with the custom which has thus been established. It is to be hoped that the *Archives* will go on to new heights of achievement as the combined specialty of physical medicine and rehabilitation gradually becomes crystallized. We believe that practice, teaching and research in the joint fields of physical medicine and rehabilitation should go forward hand in hand and that the change of the name of the *Archives* is a definite step in the right direction.

MEDICAL NEWS

Members are invited to send to this office items of news of general interest, for example, those relating to society activities, new hospitals, education, etc. Programs should be received at least three weeks before the date of meeting.

Additional Physical Therapy Schools Approved by A.M.A.

The following physical therapy schools have been officially approved by the Council on Medical Education and Hospitals, American Medical Association at the Denver meeting, December 1, 1952:

University of Connecticut, Storrs, Conn.

Charity Hospital of Louisiana, New Orleans, La.

University of Michigan, Ann Arbor, Mich.

University of Buffalo School of Medicine, Chronic Disease Research Institute, Buffalo, N. Y.

Grady Vaughn School of Physical Therapy, Baylor University Hospital, Dallas, Texas. (Approved July 30, 1952.)

New England Society Meets

The New England Society of Physical Medicine met in Boston on Wednesday, December 10. Dr. William T. Green presented the following program:

"The Management of the Patient with Acute Poliomyelitis." Dr. Green spoke on the Principles of Care; Dr. D. S. Grice on Orthopedic Supervision; Dr. B. G. Ferris on The Elastic Characteristics of the Lungs and Chest Wall in Polio and Its Significance; Dr. A. W. Trott on Respirator Care; Mrs. Elizabeth Zausmer on Physiotherapy Techniques, and Miss Mary Kerr on Nursing Care. **Jacob L. Rudd,** M.D., is President.

Cleveland Society Elects

On December 3, 1952, the following officers were elected for 1953, Cleveland Society of Physical Medicine and Rehabilitation: **Harry T. Zankel,** President; **Roswell Lowry,** Vice-President; **Bert Treister,** Secretary-Treasurer. The Board of Directors consist of the following: **Walter M. Solomon, Walter J. Zeiter** and **Paul Nelson.**

Postgraduate Courses in Physical Medicine and Rehabilitation

The following schools are offering post-graduate courses during 1953: University of California, Los Angeles; New York Polyclinic Medical School and Hospital, New York City; New York University Post-Graduate Medical School, New York City; and University of Pennsylvania Graduate School of Medicine, Philadelphia, Pa. For information concerning dates and tuition, write direct to the school.

Personals

Jerome S. Tobis, M.D., New York City, has been appointed to the staff of consultants to The Kessler Institute for Rehabilitation.

Odon F. von Werssowetz M.D., Nashville, Tenn., was recently elected an honorary member of the Midwest Clinical Society.

Louis N. Rudin, M.D., Baltimore, Md., has been appointed Consultant in Physical Medicine and Rehabilitation, VA Hospital, at Baltimore.

Dr. **Arthur A. Rodriquez,** Chicago, Ill., appeared on TV, Nov. 20 by presenting the topic "New Horizons." A paraplegic who had been rehabilitated at the Department of Physical Medicine and Rehabilitation, Research and Educational Hospitals of the University of Illinois, appeared on the program. Dr. Rodriquez gave an illustrated talk on Nov. 26 to the Chicago Rheumatism Society. The talk was entitled "The Importance of Physical Medicine and Rehabilitation in Rheumatology."

Louis B. Newman, M.D., delivered an illustrated lecture on "Physical Medicine and Rehabilitation in Orthopedic Disabilities," before the Chicago Orthopedic Society on November 14, 1952.

Henry H. Kessler, M.D., Newark, N. J., was chairman of a special session to consider the subject "Care and Education of the Physically Handicapped Child," held in Bombay, India, December 5-12.

Herbert Park, M.D., is now Professor of Physical Medicine and Rehabilitation at the Medical College of Virginia, Richmond, Va. Dr. Park was formerly at Woodrow Wilson Rehabilitation Center, Fishersville, Va.

Louis B. Newman, M.D., Hines, Illinois, addressed the State Board of the Illinois Federation of Women's Clubs in December, 1952. His address was entitled, "The Civilian's Role in the Rehabilitation of the Veteran."

Frederic B. House, M.D., Ann Arbor, Michigan, was elected for a term of three years to the Ann Arbor Board of Education.

Dr. **Howard A. Rusk,** New York, N. Y., delivered the first annual Joseph H. Pratt lecture entitled "Medicine's Number One Problem," at New England Center Hospital, Boston, Mass., on December 5. Dr. Rusk is also scheduled to present the topic "Reflabilitation: A Medical Responsibility," at Mount Sinai Hospital, New York, N. Y., on February 4.

Winfred Overholser, M.D., Washington, D.C., delivered the Isaac Ray lectures on psychiatry and the law at Harvard University.

Carl M. Akwa, M.D., Milwaukee, Wis., a co-author of the article entitled "Adapted Wheelchair for Above-Knee Amputees," published in the March, 1952, issue of the ARCHIVES, died on October 15 at the age of 31.

The Section on Physical Medicine and Rehabilitation will have a scientific exhibit at the A. M. A., New York Session, June 1-5, 1953. Dr. **Arthur L. Watkins** of Boston is the representative of the section.

New VA Appointments

Dr. **Diego A. Mattarella** has been appointed Assistant Chief, Physical Medicine Rehabilitation Service, Crile VA Hospital, Cleveland, Ohio. He will be in charge of the General Medical and Surgical Division and Physical Medicine Rehabilitation Ward.

Dr. **Bruce B. Sutton** has been appointed Assistant Chief, Physical Medicine Rehabilitation Service, Crile VA Hospital, in charge of Paraplegia Section.

Dr. **Stanley F. Radzyminski** has been transferred from Crile VA to the Wadsworth VA Center, Wadsworth, Kansas. He will be Chief, Physical Medicine Rehabilitation Service.

Summer Camp for Handicapped Children

Camp Jened, Green County, Hunter, N. Y., will be opened in July, 1953, for physically handicapped children and young adults. It will combine a camp experience with an integrated therapy program. The capacity of the campsite is 200, 150 children and 50 young adults. Correspondence concerning the camp should be directed to Mrs. Leona S. Burger, Director, Camp Jened, 1434 Genesee St., Utica, N. Y.

Cerebral Palsy Program

The Children's Hospital at San Francisco, California, has established a program to aid the very young brain-injured child. The sponsor is the United Cerebral Palsy Association of San Francisco. Such services as physical, occupational and speech therapy are included, as well as a prenursery school program, social service, child guidance and parent education.

New Journal on Geriatrics

The new publication of The American Geriatrics Society entitled Journal of the American Geriatrics Society will appear very shortly. Any physician interested in diseases of the aging can apply for membership. For additional information, write to the permanent secretary, Dr. Malford W. Thewlis, Wakefield, R. I.

Mobile Units for Physical Therapy

Mobile units have been set up by four chapters of the National Arthritis and Rheumatism Foundation to enable physical therapists to take portable equipment to the homes of rheumatic disease patients. The chapters are located in Arizona, Northern California, Michigan and the District of Columbia. The Canadian Arthritis and Rheumatism Society has a similar operation in Canada.

Rehabilitated Employed in Illinois

The Illinois Division of Vocational Rehabilitation has established a record in rehabilitating and employing disabled persons. As of June 30, approximately 4050 handicapped were placed in jobs.

Academy Officers

The following officers have been elected by the American Academy for Cerebral Palsy for the coming year: Arnold Gesell, M.D., President; Meyer A. Perlstein, M.D., President-Elect, and Harry E. Barnett, M.D., Secretary-Treasurer.

Geriatrics Ward

The Dr. Bertha Van Hoosen geriatrics ward was dedicated September 30 at the Women and Children's Hospital, Chicago, Ill. It is believed to be the first of its kind in Chicago devoted to the exclusive use of the aged.

New Bill Proposed

H. 2358 — Massachusetts — Relates to the powers and duties of the state board of vocational education, proposes that rehabilitation facilities shall include medical, surgical, hospital, prosthesis, vocational, educational, and physical restoration services and directs the state board of vocational education to establish a list of physicians qualified to render competent rehabilitation services.

Sound Film Available

The sound film entitled "Journey to Reality" produced by the U. S. Army is available on loan from the Area Surgeon of the Army area in which the request originates. It points out the value of prescribed occupational therapy.

Congress to Meet

Annual Congress on Medical Education and Licensure — Monday and Tuesday, Feb. 9-10, 1953, Red Lacquer Room, Palmer House, Chicago, Ill.

John D. Currence

It is with deep regret that we announce the death of John De Paul Currence, New York, N. Y. Dr. Currence was a Board diplomate and Congress member for many years. His death occurred on October 20, 1952.

Newly Registered Therapists

November 12, 1952

Bloch, Armond, 621 25th St., Oakland, Calif.

Corder, Carol Jean, 2728 Benvenue, Berkeley 5, Calif.

Hardgrave, Nancy Ann, 1500 6th Ave., San Francisco, Calif.

Johnson, Kathleen Margaret, 149 Parkside Circle, Decatur, Ga.

Kame, Bernice, Rt. 4, Box 1001, Visalia, Calif.

Low, Jack, 1400 Stannage Ave., Berkeley, Calif.

Maybeck, Adriana deGraaf, 2751 Buena Vista, Berkeley, Calif.

Millard, Rachael Ellen, 3506 Balch, Fresno, Calif.

Porrino, Peter Dominic, 229 Blatchley Ave., New Haven 13, Conn.

Scarich, Rosemary Zorka, 2211 Rose St., Berkeley, Calif.

Smith, Roy Gene, 1850 Arch St., Berkeley, Calif.

Wham, Paul James, Jr., 6404 Hickory Ave., Fair Oaks, Calif.

November 14, 1952

Amick, John Robert, % Dr. A. J. Amick, Stanton, Nebr.

Brown, Arnold, 457 7th St., Palisades Park, N. J.

Cook, Mildred Roberts, 181 Lakeview Ave., Scarsdale, N. Y.

Dean, Dolores Ann, 1130 Tennessee St., Lawrence, Kan.

Dennis, Elizabeth Ann, 409 W. Curtis, Topeka, Kan.

Face, Leonard Raymond, Lake Tomahawk, Wis.

Filchock, John Andrew, 331 E. 84 St., New York 28, N. Y.

Franklin, Anne Liddell, 1021 Ardsley Rd., Charlotte, N. C.

Goddard, Wynona Addie, 63 Columbian Ave., Athol, Mass.

Hieber, Mary Elizabeth, 1900 Springmill Rd., R. D. 1, Mansfield, Ohio.

Lomelino, Elizabeth Ann, R. F. D. 1, Modesto, Ill.

Midwood, Albert George, 50 Rose St., Kearny, N. J.

Moore, Martha Hughes, 26 Elkhorn St., Welch, West Va.

Mucci, Henry Peter, 28 Mill St., Wappingers Falls, N. Y.

Pedicini, Cosimo Anthony, 109 Pine Grove Ave., Summit, N. J.

Pond, Marilyn Williams, 224 Thornton St., Hamden, Conn.

Rockwell, John Dudley, 902 Ford St., Bremerton, Wash.

Rosenthal, Jane Ann, 216 Commercial St., Provincetown, Mass.

Spaulding, Barbara, Box 94, Ivanhoe, Va.

Sprague, Robert Beyea, 513 Manatuck Blvd., Brightwaters, N. Y.

Strulowitz, Daniel Stanley, 79 Crescent Ave., Jersey City, N. J.

Supple, George Crawford, Lovell St., Lincolndale, N. Y.

Tutt, Nancy Jean, 217 Church St., Lexington, Ky.

Vega, Rosario-Lutgarda, Barcelona 189, Valencia, Rio Piedras, P. R.

Welge, Charles Henry, Jr., 604 Warburton Ave., Yonkers, N. Y.

Wood, Esther Elizabeth, 70 Grand Ave., Atlantic Highlands, N. J.

Woodworth, James Kenneth, Garnet Mine Rd., Boothwyn, Pa.

November 19, 1952

Rolander, Hildegarde Ann, 40 Boyd St., Worcester 5, Mass.

Thompson, Ellis L., R. F. D. 2, Box 75B, Hammond, La.

December 2, 1952

Garcia, Ilia Marie, Guayama 19, Hato Rey, P. R.

Geldmacher, Barbara Jean, 504 Gazin, Houston, Texas.

Gimbel, Gilbert M., 7209 Old Main St., Houston, Texas.

Gimbel, Jeannine B., 7209 Old Main St., Houston, Texas.

Lanoux, Leonce Paul, Jr., 6422 Auden, Houston, Texas.

Lee, Cecelia Julia, 6843 Crestmont, Houston, Texas.

Pepper, Nathan Hale, 4132 Drew, Houston, Texas.

Rumbaugh, Hazel Margaret, 1285 Schex Dr., Bossier City, La.

Smith, Shelly Vance, Rt. 4, Box 86, Georgetown, Texas.

Works, Doreen Catherine, Augusta, Wis.

Zesch, Billy Don, 225 Travis St., P. O. Box 376, Kerrville, Texas.

December 4, 1952

Barney, Vermon S., Panguitch, Utah.

Cleveland, Bernice June, 3281 Veteran Ave., Los Angeles 34, Calif.

Cutler, Jean Frances, 741 N. La Jolla Ave., Los Angeles 46, Calif.

Daughters, Carlyn Lorraine, 2020 E. Lynn, Seattle, Wash.

Dycer, Hanon Virginia, 1153½ S. Bronson Ave., Los Angeles 19, Calif.

Fischer, Ernece Rae, 5701 Hub St., Los Angeles 42, Calif.

Holmes, Ila Davidson, 5221 De Longpre Ave., Los Angeles 27, Calif.

Labowe, Trana Kanner, 4618 Los Feliz Blvd., Apt. 2, Los Angeles 27, Calif.

McLennan, Shirley, 8704½ Bonner Dr., Los Angeles 48, Calif.

Ruste, Charles Erick, 299½ W. Grandview Ave., Sierra Madre, Calif.

Sherman, Claire Walkin, 3366 McLaughlin Ave., Los Angeles 34, Calif.

Spielman, Joan Zsupnik, 1851 S. La Brea, Los Angeles 19, Calif.

December 9, 1952

Bernardi, Mary Catherine, Box 44, Federal, Pa.

Bugbee, Barbara Belle, 3150 N. 17th St., Terre Haute, Ind.

Custeau, Rita Laura, 820 Lakeview Ave., Lowell, Mass.

Esposito, Madelyn Ann, 222 Mary St., Old Forge, Pa.

Hofstad, Gudrun Agnes, 16 Lincoln Lane, Northfield, Minn.

Smith, Marion Augusta, 3650 S. Huron, Englewood, Colo.

Van Scoy, Jane Lucille, Squiretown Rd., Hampton Bays, N. Y.

Van Scoy, Joan Lorraine, Squiretown Rd., Hampton Bays, N. Y.

December 13, 1952

Belle, William Paul, 705 S. Howard Ave., Tampa, Fla.

Carleton, Phyllis Elizabeth, 721 Copwell Ave., Toronto, Ont., Can.

Daugherty, William Boyer, 411 Rawling St., Washington Court House, Ohio.

Deeley, Dorothy Jean, 101 Coulston Ave., Asbestos, Que., Can.

Dozier, William Thomas, 17 S. Bloodworth St., Raleigh, N. C.

Martin, Catheryn Schmidle, Box 69, Fairmouth, W. Va.

Peterson, Charles Mervin, Jeffersonville, N. Y.

Robinson, Jean Lowell, 189 Third Ave., Ottawa, Ont., Can.

Ross, Ned Moses, Route 4, Burlington, N. C.

Soo, Kit-Wan, Box 6923, College Station, Durham, N. C.

Spring, Mary Louise, 1322 Nineteenth St., Orlando, Fla.

Visconti, Francis Thomas, 1011 New York Ave., Union City, N. J.

Wiencke, Marian Louise, West Point Pleasant, N. J.

Williams, Priscilla Talbutt, 1107 Alabama Ave., Durham, N. C.

Apparatus Accepted

Ille Hydromassage Subaqua Therapy Units. — Manufactured by Ille Electric Corporation, 50 Mill Rd., Freeport, L. I., N. Y., devices are designed to permit the immersion of a patient's extremities in warmed, agitated water. Models HM-300, 400, 500, 600 and 601 are included; essential difference is size. The Council on Physical Medicine and Rehabilitation voted to include the units in Apparatus Accepted.

Chronowave Electrostimulator, Model 320. — Manufactured by R. J. Lindquist Company, 2419 W. Ninth St., Los Angeles 6, Calif., device generates electric currents for muscle stimulation, ion transfer and electrodiagnosis. The Council on Physical Medicine and Rehabilitation voted to include the apparatus in its accepted list.

Melco Oxygen Tents, Models 262 and 360. — Manufactured by Melchior Armstrong, Dessau Company of Delaware, Inc., 730 Grand Ave., Ridgefield, N. J., devices administer oxygen for long periods to patients in bed. The Council on Physical Medicine and Rehabilitation voted to include the tents in Apparatus Accepted.

Respirair Portable Plastic Respirator. — Manufactured by Fabrikators, Inc., of Massachusetts, 19 Walnut St., Boston 32, Mass., device is cuirass type for administering artificial respiration by application of alternating positive and negative pressure to the patient's chest. Its usefulness in respiratory paralysis due to acute poliomyelitis is confined to transporting of patient from a remote place to a center where a tank type respirator is available. The Council on Physical Medicine and Rehabilitation voted to include the apparatus in its accepted list.

General Electric Inductotherm, Model F, Type 1. — Manufactured by General Electric Co., X-Ray Dept., 4855 W. Electric Ave., Milwaukee 14, Wis., instrument is crystal-controlled generator of electromagnetic radiation, and bears FCC Type Approval. The Council on Physical Medicine and Rehabilitation voted to include the device in Apparatus Accepted.

Electrolor Oxygen Tent, Model 570. — Manufactured by McKesson Appliance Co., 2226 Ashland Ave., Toledo 10, Ohio, apparatus is electrically refrigerated for prolonged administration of oxygen to patients in bed. The Council on Physical Medicine and Rehabilitation voted to include Model 570 in its accepted list.

Dr. Rusk Wins Criss Award

Dr. Howard A. Rusk, of New York, was named as the 1952 winner of the $10,000 Dr. C. C. Criss Award and gold medal in recognition of his work in rehabilitating the physically handicapped. The award was established by Mutual Benefit Health and Accident Association of Omaha to honor outstanding contributors to the fields of health and safety.

International Circulation of Films on Services for the Disabled

The International Society for the Welfare of Cripples has undertaken to build up a library of suitable motion picture films. A substantial number of films which are most useful in connection with services for the disabled are presently being provided internationally. For complete information on this film service, write ISWC, 127 E. 52nd Street, New York 22, N. Y.

BOOK REVIEWS

The reviews here published have been prepared by competent authorities and do not necessarily represent the opinions of the American Congress of Physical Medicine and Rehabilitation.

BIOCHEMISTRY AND HUMAN METABOLISM. By *Burnham S. Walker,* M.D., Ph.D., Professor of Biochemistry, Boston University, School of Medicine, *William C. Boyd,* Ph.D., Professor of Immunochemistry, Boston University School of Medicine, and *Isaac Asimov,* Ph.D., Assistant Professor of Biochemistry, Boston University School of Medicine, With a Foreword by *John T. Edsall,* M.D., Professor of Biological Chemistry, Harvard University. Cloth. Price, $9.00. Pp. 812. The Williams & Wilkins Company, Mt. Royal and Guilford Aves., Baltimore 2, 1952.

Dr. Edsall attributes to this book "a freshness and vitality . . . which give it a distinctive place." He is quite right. Most standard texts are organized by and for the chemist. The aim here is to sustain the interest of one who is medically oriented. The organization is in physiological terms. The book is not, as the title wrongly implies, unduly anthropocentric, although clinical relevancies and applications are interpolated; particularly valuable are succinct descriptions of methods, which so greatly help the reader in understanding how conclusions have been reached.

As in any first edition, certain aspects might be altered or revised. One is the Roman enumeration of formulae; this is justified by custom, but Arabic numerals are so much easier to find. The discussion of pH is perhaps a little long, as is also that of heredity. These are minor points and arguable. The fact that heredity is reviewed in the light of biochemistry illustrates the commendable character of the book.

Only those who teach undergraduates can judge its value in the schools. The reviewer's approach is that of a graduate interested in reviewing the advances of the past 20 years. This is the best text he has seen for the general reader similarly inclined. It is well written, well made; to its authors and publishers, "Well done, Sirs!"

SOCIAL MEDICINE. By *E. H. Cluver,* K.St.J., E.D., M.D., Director, South African Institute for Medical Research, Johannesburg. Cloth. Price, $13.50. Pp. 862. Hafner Publishing Co., Inc., 31 East 10th St., New York 3; Central News Agency, Ltd., Corner Rissik and Commissioner Sts., Johannesburg, South Africa, 1951.

A committee was set up by the joint Universities Committee of South Africa on Social Studies to consider the question of sociological teaching in the medical faculties of the South African Universities. That committee agreed that such teaching should make provision for Social Medicine as a special subject of study. It was evident that a textbook was essential, and Doctor Cluver was invited to write such a book with the assistance of all those having special knowledge of the various aspects of social medicine. The present text is the culmination of the strenuous efforts of the author and his splendid staff of collaborators.

The text is presented in six parts with each part subdivided into the necessary chapters. Half of the chapters, comprising the whole of Parts II and IV, have been contributed by recognized authorities holding university teaching positions which qualify them especially for the task. This book is primarily concerned with the vast bulk of ill-health productive of great misery, pain, and incapacity, which is completely preventable and the persistence of which is attributable to our social inadequacy. Eugenics, the author believes offers little help as a practical method of improving the human species.

Part one discusses the causes of human disorganization and is subdivided into two excellent chapters: social influences and human genetics. Part two is entitled personal disorganization, with the following well outlined chapters: somatic, somatopsychic, psychosomatic, the neuroses, psychic disorganization and the psychoses. Part three is concerned with social diseases and comprises the following chapters: social diseases, tuberculosis, industrial diseases, leprosy, venereal diseases, malaria, yellow fever, typhus and plague. Part four discusses social disorganization in the following chapters: poverty, crime, world food problems, malnutrition, the physically disabled, speech disorganization, industrial welfare, family disorganization and health center service. Part five is given over entirely to statistics, and the authors present methods and illustrate the place of each method. This is a most valuable chapter because it is written entirely from the medical viewpoint. It is unusual to find an explanation of statistical methods so well done in a medical text. Part six discusses medico-social legislation and is pertinent to South Africa.

This is an unusual book, well outlined and comphrensive in its presentation. Physiatrists will find that physical medicine is given a due place of recognition in the treatment of many conditions. There is an unusually good discussion of exercise and the effects of physical training. The book should fill a very definite need for the young practitioner and student of medicine, besides filling a serious gap in medical literature. While the text was written to fill a specific need in South Africa,

it carries a universal message and is highly recommended.

SYNOPSIS OF GENITOURINARY DISEASES. By *Austin I. Dodson*, M.D., F.A.C.S., Richmond, Virginia; Professor of Genitourinary Surgery, Medical College of Virginia; Genitourinary Surgeon to the Hospital Division, Medical College of Virginia; Genitourinary Surgeon to Crippled Children's Hospital; Urologist to St. Elizabeth's Hospital; Urologist to St. Luke's Hospital and McGuire Clinic, and *Donald I. Gilbert*, M.D., Instructor in Urology, Medical College of Virginia. Fifth edition. Fabrikoid. Price, $4.00. Pp. 313, with illustrations. The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, Mo., 1952.

That this small but excellent synopsis has been successful and has met a fundamental need is evident, since this is the fifth edition after the initial publication in 1934. The principal changes in the present edition are found in chapter two, dealing with the advances in antibiotics and chemotherapy. Other minor changes are found throughout the book to keep the reader abreast of urological advances. The purpose of the authors was to present a synopsis of genitourinary diseases so that the essential facts connected with urology may be readily grasped by the student of medicine and to provide a handy reference for the physician in practice. These objectives have been well met.

Chapter one is a summary of the most prominent signs and symptoms of urogenital diseases and should prove a helpful guide for the student at the bedside. Chapter two describes the urological instruments for minor procedures and internal medication. Chapter three gives a brief description of the anatomy of the genitourinary organs. Chapter four deals with anomalies. The remaining ten chapters are arranged largely according to diseases.

PHYSICS AND MEDICINE OF THE UPPER ATMOSPHERE. A STUDY OF THE AEROPAUSE. Editors: *Clayton S. White*, M.D., Director of Research, Lovelace Foundation for Medical Education and Research, Head of Section of Aviation Medicine, Lovelace Clinic; and *Otis O. Benson*, Jr., Brigadier General, USAF (MC), Commandant, USAF, School of Aviation Medicine. Cloth. Price, $10.00. Pp. 611. The University of New Mexico Press, Albuquerque, New Mexico, 1952.

It is difficult to convey in a short review an appreciation of the importance and fascination of this extraordinary work. Into it a group of collaborating specialists have concentrated the results of much highly organized modern research, all focussed upon the medical problems arising from the development of rocket craft.

Such craft will soon be ready to carry human passengers into regions where there is neither air nor the security afforded by the accustomed strong pull of gravity at the surface of the earth. The dangers of anoxia, of explosive decompression, of extreme heat and cold, of solar X-rays and other ionizing radiations, of meteoric masses, of weightlessness and excessive accelerations — all are calculated with the same minute and relentless logic that has already led to the transmutation of elements, the disruption of the atom, and so many other incredibilia of modern life. Every branch of science is here represented in unexpected special applications — the mathematics of the orbit of an artificial satellite, the mechanics of a rocket rotating as it ascends, the physics of cosmic rays, the physiology of parachute drops, and the toxicology of diborane and tetranitromethane. For the physiatrist there are innumerable passages of special interest, such as the section on atmospheric ozone and its relation to the solar ultraviolet radiation.

It is hard to imagine a medical reader who will not find inspiration in this book. Embodying a vast repertory of facts plus the soberly worded deductions therefrom, edited with gratifying smoothness, provided with essential references and a good index, this book should be in every medical library as laying the ground work of scientific space medicine.

PRINCIPLES OF ORGANIC EVOLUTION. By *Arthur Ward Lindsey*, Professor of Biological Sciences in Denison University, Granville, Ohio. Cloth. Price, $5.75. Pp. 375, with 216 illustrations. The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, Mo., 1952.

This splendid textbook on organic evolution will not appeal to the average physician who has difficulty in keeping pace with his own specialized literature. The book was written primarily as a textbook for those students approaching the subject as a part of a liberal education as well as for those students whose interest is purely scientific. This volume affords a broad survey of the subject.

The tremendous growth of genetics and its application to the study of organic evolution has been responsible for the trend of the outstanding modern books on evolution. They have led to a rather general acceptance of the idea that natural selection and mutation are the only valid processes of evolution. At the risk of being condemned as a neo-Lamarckian, the author presents a broad and unbiased survey of the entire subject and the most recent contributions of Lamarckian flavor are considered impartially with those of genetics.

The text is divided as follows: the first two chapters deal with an introduction and the history of evolution. Four chapters discuss the relationship of organisms. Two chapters are devoted to evidences of evolution; five chapters are given to a survey of the evolution of existing forms; and the process of evolution is subdivided under the heading of (1) the foundations and (2) the process: theories and experimental evidence. The closing chapter is on the importance of evolution in human life.

Doctor Lindsey has presented the subject matter in a clear, concise, interesting and certainly comprehensive manner and for those interested in this fundamental and vital subject, this excellent text is highly recommended.

FRACTURES AND JOINT INJURIES. Volume I. By *Sir Reginald Watson-Jones,* B.Sc., M.Ch.Orth., F.R.C.S., Orthopedic Surgeon to His Majesty the King, London. Fourth Edition. Cloth. Price, $22.00 per set. Pp. 443, with 709 illustrations. Williams & Wilkins Company, Mount Royal and Guilford Aves., Baltimore 2, 1952.

It is refreshing to review the new fourth edition of "Fractures and Joint Injuries," by Sir Reginald Watson-Jones, for here, as is too seldom done, the book has not been recopied but has been rewritten. The entire two volumes have been reworked and an honest attempt has been made to bring this book as much up-to-date as any textbook can be. It has been kept in a two-volume edition, which obviates the problems involved in one large, bulky book with breaking of the binding and the trouble involved in the handling of a thick volume.

There has been an obvious effort made to avoid unnecessary verbiage, and as a result the volume reads not only extremely well but remains concise and to the point. The author has also succeeded in arranging and writing his subject material in such a fashion that the book is probably of equal value either to a person doing general traumatic work or to a specialist in orthopedic surgery. Outstanding among the new portions of the volume is the section on bone grafting, emphasis being laid upon the value of cancellous bone, its rapidity of take, and its ease of manipulation. Also outstanding is the rewritten chapter on injuries and degenerations of the rotator cuff of the shoulder, which is a subject that the reviewer feels will become more and more significant as time goes on. The section on fractures of the spine with associated paraplegia remains a classic in its field. The new illustrations are excellent and refreshing; the famous "peep" illustrations have been maintained. The text remains authoritative because of the author's experience and the volume of cases which have been available. One of the outstanding features of the book lies in the fact that not only is diagnosis and treatment of specific injuries quite adequately covered but there has been a definite attempt to bring the factor of function into the rationale for whatever form of treatment is being advocated.

The volume remains pre-eminent in its field.

THE CLINICAL USE OF FLUID AND ELECTROLYTE. By *John H. Bland,* M.D., Assistant Professor of Medicine, University of Vermont College of Medicine. Paper. Price, $6.50. Pp. 259 with 75 illustrations. W. B. Saunders Company, West Washington Sq., Philadelphia 5, 1952.

This is the second of a series of monographs intending to bring to the medical profession the practical results of research in special fields of medicine. The great progressive strides made in biochemistry and physiology are founded largely on work of a very technical and highly specialized type, and the student, interne, resident and physician have great difficulty in the interpretation and clinical utilization of this new information. The aim of the author is to provide a practical usable guide to the recognition and treatment of the various fluid and electrolyte abnormalities that may arise in medical and surgical patients. Of special note is a chapter devoted along these lines to the geriatric patients for whom, the author states, such therapy, well planned and carefully founded, so frequently makes the difference between life and death. A considerable part of the chapter is based on the writer's experience and initial investigations in this group of patients so long neglected.

The extremely important applicability of this field of information to all branches of medicine makes it incumbent upon all those who see patients clinically from day to day to have a knowledge of the physiology and chemical pathology of body water and electrolytes. There are thirteen chapters which deal with the following subjects: basic physiologic considerations of body fluid and electrolyte; "pure" water and mixed water and sodium depletion; water and electrolyte in congestive heart failure; normal and abnormal potassium metabolism; water and electrolyte in pediatric patients; fluid and electrolyte in the aged and aging; parenteral fluids in surgical patients; fluid and electrolyte in renal disease; fluid and electrolyte in diabetes mellitus; fluid and electrolyte in adrenal cortical insufficiency; adverse effects of heat on body water and electrolyte, ACTH and Cortisone: Physiologic Effects in Body Fluid and Electrolyte; and behavior of body water and electrolyte in shock, burns, crush and blast injury; roentgen irradiation and exposure to cold and other stress.

Doctor Bland has rendered a valuable service to the busy practitioner in presenting this timely monograph. Saunders Company is to be congratulated for publishing it in such an inexpensive manner. It is an excellent example of planographing. The illustrations are numerous and very legible. This volume should find a ready market and is well recommended.

CONNECTIVE TISSUES. Volume I. TRANSACTIONS OF THE FIRST CONFERENCE, APRIL 24-25, 1950. New York, N. Y. Edited by *Charles Ragan,* Department of Medicine, College of Physicians and Surgeons, Columbia University. Cloth. Price, $3.25. Pp. 164, with illustrations. Volume II. TRANSACTIONS OF THE SECOND CONFERENCE, MAY 24-25, 1951 New York, N. Y. Edited by *Charles Ragan,* Cloth. Price, $3.50. Pp. 190, with illustrations. Josiah Macy, Jr. Foundation, 565 Park Avenue, New York 21, 1951 and 1952.

The past decade has seen the development of an exciting trend in the presentation of discussions related to scientific problems of the most advanced character, discussions which have aroused the most laudable expressions from the authoritative voices in all the related fields of medicine. Under the sponsorship of the Josiah Macy, Jr. Foundation, a series of conferences, limited to selected members and a small number of invited guests of unquestioned eminence in their respective fields, have to date already contributed fifteen reports available from these transactions and of most praiseworthy character.

The procedure of these transactions is that of the studied informality of a round-table conference. Under such a planned freedom of thought and expression the two volumes of the transactions concerning "Connective Tissue" came into being, not only because of its great importance in the maintenance of bodily integrity such as growth and defense, but because our increasing orientation is daily discovering new interpretations for our former limited interest in this subject. Discussion of this tissue, supporting scaffold of all living cells, provided a heterogeneous discussion expressing the newer thoughts and techniques of research in relation to such fundamental subjects as ground substance, the chemical morphology of elastic tissue, the pain mechanism of connective tissue, the nature of collagen, the effect of ACTH and Cortisone, enzymes, repair processes, regression of scar tissue and the like. This conference, its members and guests, all eminent investigators, including anatomists, pathologists, physicians, nutritionalists, microbiologists, psychologists, and clinicians, certainly represents the highest authority.

Worthy of unstinted praise, to select a few from the many, are the discussion by Travell on the pain mechanism in relation to the nature of connective tissue, the valuable observations of Ragan on the hormone influence in tissue healing, as well as his editorial contribution of distinguished quality. Nor can one close this topic without mention of the valuable labors of Dr. Fremont-Smith as medical director of these conferences. These published reports carry the hallmark of excellence and fills a need recognized by all related workers in medicine and promises most rewarding reading.

It is to be hoped that some generous humanitarian will recognize in physical medicine a similar opportunity to disseminate its innovations and new discoveries and thus shorten the great lag between discovery and recognition of the progress in this discipline. Such a provocative endeavor could well attract its top echelon and thus render an inspirational service to a group which hitherto has been operating on a minority and disorganized basis.

BUILDING HAPPY USEFUL LIVES FOR THE HANDICAPPED. A RECORD OF THE 1950 CONVENTION OF THE NATIONAL SOCIETY FOR CRIPPLED CHILDREN AND ADULTS. Hotel Stevens, October 26-28, 1950. Paper. Price, $1.25. Pp. 120. The Easter Seal Agency, 11 South La Salle Street, Chicago.

This booklet is a transcription of the proceedings of the 1950 convention of the National Society for Crippled Children and Adults. The talks and discussions of the various sessions have been printed in their entirety. Most of the talks were short, and many of the programs consisted of panel discussions by authorities from various groups interested in the rehabilitation of crippled children and adults. One interesting panel was presented by a group of successfully rehabilitated persons. An outstanding statement on the responsibility of the patient was made by Mrs. Elsie Oaks Barbour. Although this statement is less than a page long, it provides worth-while reading for every handicapped person and should be read by those who are interested in their rehabilitation.

The needs and problems in the various fields are well presented, as are reports on work in progress in the different states of disability and with various groups of handicapped persons at the time of publication. Some of the clinics that were recorded are of little interest when presented, as is necessary in a book, without the patients. This booklet provides useful orientation on work that is being done for handicapped people, and could serve as a guide to teachers, social-service workers, physical therapists, occupational therapists and physicians.

THE HEALING TOUCH. By *Harley Williams* Cloth. Price, $6.75. Pp. 370, with illustrations. Charles C Thomas, Publisher, 301-327 E. Lawrence Ave., Springfield, Ill., 1951.

This is a collection of portraits of doctors and persons associated with medicine. The first section concerns three physicians who attended royalty, beginning with Sir William Knighton who spent fifteen years in the service of George the Fourth. The chapter relates more about the intimacies and indiscretions of this king than of his physician. A chapter on Florence Nightingale tells of her difficulties and the state of medical practices of her time. The final section concerns medicine in the United States including the story of the Mayo family, Halstead, Welch, and Harvey Cushing.

This book is interesting, not only in the actual story of the individuals but in the description of the particular era and of its influence on these persons. It is written so as to appeal to lay persons and medical profession.

CEREBRAL PALSY INSTITUTE PROCEEDINGS. November, 1950. Sponsored by The Coordinating Council for Cerebral Palsy in New York City, Inc. Prepared by *Marguerite Abbott*, B.S., O.T.R., Executive Director, The Coordinating Council for Cerebral Palsy in New York City, Inc., 270 Park Avenue, New York, New York. Paper. Price, $1.50. Pp. 136. Association for the Aid of Crippled Children, Inc., 580 Fifth Avenue, New York 36.

This book consists of 31 papers, each by a different author and on a different aspect of cerebral palsy, from etiology to employment. The style varies over a wide range, from the diffuse and inaccurate meanderings of over-confident authorities to the compact, carefully organized summaries of experience by contributors who respect the limitations of time and space. The reader soon learns to appreciate the latter type of paper. The book as a whole is a most commendable example of concerted endeavor, and will be a priceless help to anyone concerned with cerebral-palsied patients.

PHYSICAL MEDICINE ABSTRACTS

Objective Evaluation of Physical and Drug Therapy in the Rehabilitation of the Hemiplegic Patient: I — A Study of Dihydroergocornine (DHO-180). Joseph G. Benton; Henry Brown, and Seymour H. Rinzler.

Am. Heart J. 42:719 (Nov.) 1951.

Using the "double-blind" technique of administration, Dihydroergocornine methanesulfonate (DHO-180) administered in conjunction with a formal program of physical therapy and rehabilitation to ten hemiplegic patients resulted in no significant effect on the time-course of rehabilitation as measured by serial analyses of muscle strength, passive range of joint motion, and activities of daily living when compared with seven other hemiplegic patients given placebo in addition to the program of rehabilitation. Since there was no apparent difference in these two groups, they were combined (seventeen patients) and compared with still another group of eighteen patients closely matched with regard to age, sex, etiology, and mean duration of time after the onset of the hemiplegia, but who had received no specific drug therapy or rehabilitational program. The treated group demonstrated an average accomplishment of the activities of daily living approximately 133 per cent greater than the untreated group. Smaller but appreciable increments in muscle strength and range of motion also were noted for the treated group over the untreated group. It would appear from the facts obtained by Benton, et al., that although the simple passage of time may result in a certain amount of spontaneous recovery or improvement in some hemiplegic patients, the institution of an active program of rehabilitation definitely has a favorable influence on the prognosis with regard to the return of function and particularly to the development of self-sufficiency in the activities essential to daily life.

The analysis of the data in relation to the effect of physical therapy on muscle strength, passive range of joint motion, and the activities of daily living would seem to indicate that the greatest effect of the program of rehabilitation is in re-educating the patient to use more effectively "what he has left" in daily activities rather than in producing any large increase in muscle strength or range of joint motion of the affected part. This applies, in general, to both the acute and the chronic hemiplegic patient. It appears that, unless the affected extremities recover muscle strength within the first few weeks, individual muscles recover only slightly in the ensuing months and that the ability of the patient to ambulate satisfactorily is dependent upon the success he has in learning to use the remaining normal muscles. In addition, it has recently been demonstrated by Kabat and Levine that mass movement patterns in the retraining process seem to result in a greater return of muscle function.

The Use of Splints in Peripheral Nerve Injuries. J. R. Napier.

Brit. J. Phys. Med. 14:281 (Dec.) 1951.

For the purposes of discussion the treatment of peripheral nerve injuries by splinting is divided into primary and secondary phases. During the primary phase when there is the expectation of recovery, the purposes of splinting are (1) to prevent the overstretching of paralyzed muscle and the contracture of their antagonists; (2) to prevent joint stiffness by encouraging activity; (3) to maintain the normal physiological patterns of function throughout the period of paralysis and thereby maintain functional capacity and (4) to prevent the development of trick movements. During the secondary phase where further significant recovery of muscles is unlikely the guiding principle is functional advantage and splints are selected with the object of substituting in a permanent fashion for lost muscles.

Further Investigations Into the Effects of Micro-Waves. A. C. Boyle; H. F. Cook, and D. L. Woolf.

Ann. Phys. Med. 1:3 (Jan.) 1952.

The preliminary investigation into the effects of micro-waves having been reported in a previous paper, the object of this article is to describe the results of further experimental work, the subject matter being mainly physical in character, since this is an essential preliminary to clinical application. Thus far the authors have not been able to demonstrate any effect of micro-waves other than a thermal one upon living tissues, nor does there seem to be conclusive evidence in the published literature to dispute this. They believe this to be of great importance, since the practice of physical therapy has tended in the past towards the employment of elaborate and often expensive apparatus for which extravagant claims have been made, and without due regard to the fact that simpler and cheaper measures might bring about the same therapeutic aim. The investigations into the thermal effect of micro-waves reported on herein were carried out in animals and humans, using a continuous-wave set, with a wavelength of 9.4 cm. Skin temperatures were measured during irradiation by a fine wire thermojunction attached to the applicator; the magnetron current was found to be a reliable measure of micro-wave power entering the skin. With power densities below a critical value of 0.8 watts cm.$^{-2}$, the skin temperature was maintained below 47 degrees C. by changes in skin circulation. Pain was felt if

this temperature was exceeded. Subcutaneous fat was heated less than underlying muscle, since absorption of micro-waves in fat and bone is poor compared with that in skin and muscle. During irradiation, temperatures at depths of 4 cm. from the surface rose steadily, though iso-power curves showed that most of the energy would be absorbed in the first centimeter. The contact method of application was favored because with it radiation can be measured accurately. Animal experiments showed that irradiation of regions containing superficial metallic bodies resulted in tissue necrosis with doses which were normally well tolerated. Application over subcutaneous bone was not found to be harmful.

Home Care of Patients with Acute Poliomyelitis. Philip M. Stimson.

J. A. M. A. **194**:719 (June 21) 1952.

Reasons are given for modification of the present widespread tendency to send at once to hospitals every patient whose illness is at all suggestive of acute poliomyelitis. Most patients with suspected poliomyelitis, non-paralytic forms, and many of the mild forms of the disease, might better be cared for at home, particularly if the local health authorities can provide not only diagnostic consultation to aid the family physician to differentiate poliomyelitis from other conditions, but also can provide the family physician with visiting nursing and physical therapy to care for the patients in the home. Outpatient clinics should be available for follow-up care. Cases in which home treatment is suitable are described, and their management is discussed.

In many communities a campaign of education will be needed for the sake of the neighbors. At the mere mention of poliomyelitis no one can have complete peace if mind, but most unnecessary fear can be relieved by correct information. All of this would be much less expensive than hospitalization, would lighten the demands placed on hospitals especially in times of epidemics, would satisfy the desires of the patients and their parents, and above all would avoid unnecessary exposure of the patient to fatigue of travel at a time when fatigue is damaging to a poliomyelitis patient.

Stimson also states the indications for hospitalization of poliomyelitis patients and discusses some conditions and factors that make care at home undesirable.

Empyema. T. Holmes Sellors.

Brit. M. J. **4760**:704 (Mar. 29) 1952.

Many pneumonias are cured by antibiotics; the more pneumonias cured, the fewer the empyemas. However, the distressing picture of an established chronic empyema, with toxemia, loss of lung function, and a deformed chest, should always be kept in mind as warning of what may happen if the early stages are not recognized, or are improperly treated.

Even the most efficient treatment by drugs and surgery will be of little value unless at the same time the collapsed lung expands again. The lung must be induced to re-expand, not only to obliterate the empyema space, but to restore pulmonary function. Left to his own inclinations, the patient will not move the affected part of the chest more than he can help; the instinct is to immobilize the area. But recovery is complete only when the chest walls are moving freely, and for practical purposes the movement of the chest wall is an index of lung expansion and function. A flattened rigid chest wall is almost certain to conceal an inactive area of lung.

The answer lies in the concentrated application of special breathing exercises which aim at producing a powerful and localized inspiratory excursion over the damaged area. Expiratory exercises, represented by puffing and blowing, should be ignored. The patient is instructed to breathe in deeply and forcibly against the light pressure of the physical therapist's hand without arching or bowing the spine. After a few days he should be able to concentrate the effort in any part of the chest and he must then practice without fail for 10 to 15 minutes every waking hour, with a check once or twice a day by the physical therapist. It is the conscientious patient who benefits and reduces his convalescence to a minimum.

The actual exercises are quite simple, but one must repeat that it is persistence and concentration that count. They are begun almost from the day of diagnosis and are continued with increasing intensity until complete recovery results, with the bad side of the chest moving even better than the normal side. The activities of the patient are encouraged by having him ambulant as soon as the grosser signs of toxemia have been eliminated. The practice of keeping a patient in bed during the whole period of aspiration or drainage is detrimental to early recovery. During the final stages of closure of the empyema, patients benefit by active exercise, and many of the patients walk 8 to 10 miles a day as part of their convalescent treatment.

The Ambulant Treatment of Complications Resulting from Varicose Veins and Allied Conditions. I. H. M. Curwen, and B. O. Scott.

Ann. Phys. Med. **1**:17 (Jan.) 1952.

Varicose veins and other conditions which give rise to hypostatic edema, although they are not fatal and do not shorten life, are among the commonest causes of inconvenience and incapacity at the present time. The treatment of gross varicose veins is predominantly surgical, but there are many instances in which injection or operation is not possible. In the presence of senility, constitutional disease, arteriosclerosis, or if operation is refused, the only suitable treatment is by support. Treatment is based on the painstaking work of Bisgaard (1948) whose results stimulated the adoption of the method in the Department of Physical Medicine, St. Thomas' Hospital, London, where Curwen and Scott made their observation. Its objects are as follows: first, to control the venous stasis and edema; second, to soften areas

of induration; third, to heal the ulcer and restore the health of the surrounding skin. When these objects have been achieved, the position must be maintained by the patient, who continues treatment at home by the method which he has learned while at the hospital. This method is based upon a simple triad: bandaging, massage and exercises. Massage is of value in the reduction of venous stasis and edema. For this purpose centripetal massage with the limb in elevation is used, but its effect is only temporary. It is again emphasized that the elastic support is the mainstay in the control of edema and in the assistance of the venous circulation. Massage is of greater importance when it is used in the stretching of fibrous tissue, which it renders more pliable. Deep, local friction is, therefore, used about the ulcer base and on other areas of induration. The precise physiological effect of deep frictions is not fully understood at present, but the clinical results are so manifest that great stress is laid upon its use. Cases where bandaging alone has been tried do not show the softening of areas of indurated tissue which is seen in those receiving deep massage. It is interesting to note that the acute local tenderness found in the affected limbs is rapidly relieved by treatment. The patient is instructed in the performance of exercises to mobilize the joints of the foot and ankle and to strengthen the quadriceps. Exercises are always given with the bandages in position, to reduce venous stasis. The pumping action of the muscles forces the blood from the blood vessels in the area of muscle contraction. Blood is forced along the vessels in the direction of least resistance, namely, towards the central circulation, since the elastic support exerts a constant overall pressure on the limb. Faradism is of value as a further method of controlling edema when there is gross induration in a large limb. Strong, surged, faradic stimulation of the medial and lateral popliteal nerves is given with the elastic webbing bandage in position. The resulting muscular contractions simulate the effect of active exercise. This method is useful where ankylosed joints render the performance of such exercises impossible. Of 427 cases under continuous observation, 366 have been discharged cured. Of these the incidence of recurrence was 12.2 per cent. The full results are tabulated and discussed.

Accelerated Rehabilitation in Rheumatic Fever. Albert J. Simon; Irving Mack, and Philip Rosenblum.

Am. J. Dis. Child. **83**:454 (Apr.) 1952.

Herrick House is a year-round convalescent institution for the care and rehabilitation of children recuperating from rheumatic fever. The program at Herrick House differs from that of other institutions in that mobilization is begun as soon as there is clinical and laboratory evidence that the rheumatic process is quiescent. The classic method, as opposed to this, is one of long bed rest, wheelchair, and activity-restricted convalescence.

When it is clinically noted, from observation, examination, and laboratory data that the rheumatic process is quiescent, mobilization is begun. The physical activity of the child is increased slowly, with the result that over a period varying from two to five months, depending upon the rapidity with which he reaches maximum tolerance, the child goes from bed rest with bathroom privileges (called Stage 0) to full activity (Stage 4), which may include rowing, baseball, hikes, swimming, dancing, ice skating, and sledding. Children with severer heart damage and diminished cardiac reserve progress more slowly. Between Stage 0 and Stage 4 there are intermediate stages of graded activity.

The child is advanced through successive stages of physical activity as his condition warrants. Severe heart damage will limit the activity of a few children. These children will reach a plateau of tolerance at the mildly restricted Stage 3 level, and sometimes even at Stage 2. Each patient is given individual attention, and activity tolerance is gauged by an estimate of the child's exercise tolerance correlated with the amount of heart damage. For many patients without evidence of residual heart damage the physician may increase activity by elevating the patient from Stage 1 to 3, or Stage 2 to 4. Thus, the program consists in graded physical activity combined with careful medical observation.

Use of Functional Devices for Disabilities of the Upper Extremity: Report of a Case. Lt. Col. Charles D. Shields, M.C., U.S.A.

J. A. M. A. **149**:139 (May 10) 1952.

Paralysis or weakness of muscles of the upper extremity is frequently encountered as a result of neuromuscular disorders or trauma. Tightness of fascial planes and deformities are secondary characteristics. These conditions, without bone or joint injury, seldom merit immobilization; but protection, support, and methods designed to assist and promote functional capacity must be considered. The prescription of the device or technique is a responsibility of the physician. The device must be examined when it is completed by the brace mechanic to make certain that it is properly fitted and that its purpose is being accomplished. It follows that the patient must be frequently reexamined to determine whether increased functional capacity necessitates an alteration or discontinuance of the device prescribed.

A physician who accepts responsibility for managing weakness of the upper extremity must recognize the advantages and the limitations of functional aids. There are times when motion and activity are most important, and there are times when rest is equally important. A functional aid can be intelligently prescribed only after a complete evaluation of individual weakness, tightness, and deformity, and it must be fitted to the contours and the needs of the individual patient.

A case is reported to show the relationship of a functional device to the rehabilitation effort.

APPROVED SCHOOLS OF PHYSICAL THERAPY **

Council on Medical Education and Hospitals of the American Medical Association

Name and Location of School	Medical Director and Technical Director	Entrance Requirements [1]	Duration of Course	Classes Begin	Maximum Enrolment	Tuition	Certificate, Diploma, Degree
Medical Department — U. S. Army							
(Address all inquiries to the Office of the Surgeon General, Department of the Army, Washington 25, D. C.)							
Medical Field Service School, Brooke Army Medical Center, San Antonio, Texas	Charles D. Shields, Lt. Col., M.C. Emma Harr, Maj., WMSC	e	49 wks.	Mar.-Sept.	26	None	Certificate
Fitzsimons Army Hospital, Denver	H. B. Luscombe, Col., M.C.	Affiliated with Medical Field Service School					
Letterman Army Hospital, San Francisco, California	Mary S. Lawrence, Capt., WMSC Raoul C. Psaki, Lt. Col., M.C.	Affiliated with Medical Field Service School					
Walter Reed Army Hospital, Washington, D. C.	Olena M. Cole, Maj., WMSC J. H. Kuitert, Lt. Col., M.C. Brunetta Kuehlthau, Maj., WMSC	Affiliated with Medical Field Service School					
Nonfederal							
Childrens Hospital, Los Angeles*	S. S. Matthews, M.D. Mrs. Mary J. Dodge	a-b-d	14 mos.	Sept	14	$300	Cert. or Degree
College of Medical Evangelists, Los Angeles*	F. B. Moor, M.D. R. Wm. Berdan	a-b-c	15 mos.	Sept	16	$300	Cert. or Degree
University of Southern California, Los Angeles*	C. L. Lowman, M.D.	a-b-d	14 mos	Sept	16	Univer.	Certificate
University of California School of Medicine, San Francisco*	Charlotte W. Anderson Lucile Eising, M.D.	f d	4 yrs. 12 mos.	FebSept Sept	6 16	Univer. $220[2]	Cert. & Degree Cert. or Degree
Stanford University, Stanford University, Calif.*	Margery L. Wagner W. H. Northway, M.D.	a-d-e	12 mos.	Varies	29	$690	Certificate
University of Colorado Medical Center, Denver*	Lucille Daniels Harold Dinken, M.D.	f a-b-d	4 yrs. 12 mos.	Sept Sept	16 12	$220 qr. $208[2]	Degree Cert. or Degree
Northwestern University Medical School, Chicago	Dorothy Hoag E. D. W. Hauser, M.D.	a-b-d	12 mos.	Oct	16	$450	Certificate
State University of Iowa College of Medicine, Iowa City*	Elizabeth C. Wood W. D. Paul, M.D.	e	12 mos.	Sept	20	$200	Certificate
University of Kansas Medical Center, Kansas City, Kan.*	Olive C. Farr D. L. Rose, M.D.	d	12 mos.	FebSept	3	$40[2]	Certificate
Simmons College, Boston	Ruth G. Monteith W. T. Green, M.D.	f a-e	4 yrs. 16 mos.	FebSept Sept	9 24	$40[2] College	Degree Diploma
Boston University College of Physical Education for Women, Sargent College, Cambridge, Mass.	Shirley M. Cogland Kenneth Christophe, M.D.	f c-d-e-f	4½ yrs. 1-2-4 yrs.	Sept Sept	30	Univer.	Degree Cert. or Degree
Bouve-Boston School in affiliation with Tufts College, Medford, Mass.	Adelaide L. McGarrett Howard Moore, M.D.	f	4 yrs.	Sept	16	$550	Dipl. & Degree
University of Minnesota, Minneapolis*	Constance K. Greene F. J. Kottke, M.D.	c	2 yrs.	Sept	20	$126	Degree
Mayo Clinic, Rochester, Minn.*	Ruby Green Overmann E. C. Elkins, M.D.	a-b-c	2 yrs.	Sept	38	$250	Certificate
St. Louis University, Division of Health and Hospital Services, St. Louis*	Harry Keown A. J. Kotkis, M.D.	f	4 yrs.	JanSept	12	$175 Semes.	Degree
Washington University School of Medicine, St. Louis*	Sister Mary Imelda Sedgwick Mead, M.D.	c	2 yrs.	Sept	16	$450 1st yr.[3] $328 2d yr.[3]	Degree
Albany Hospital, Albany, N. Y.	Beatrice F. Schulz J. W. Ghormley, M.D.	a-b-d	12 mos.	Sept	6	$397	Certificate
Columbia University College of Physicians and Surgeons, New York City*	Catharine Graham W. B. Snow, M.D.	f a-c-e	4 yrs. 1-2 yrs.	Sept Sept	50	$500 $680 (1 yr.)	Degree Cert. or Degree
New York University School of Education, New York City*	Mary E. Callahan G. G. Deaver, M.D.	a (+1 yr.	12 mos.	Sept	40	$1,200 (2 yrs.) $760	Cert. & Degree
Duke University, Durham, N. C.*	Elizabeth C. Addoms L. D. Baker, M.D.	coll.) b-d a-b-d	15 mos.	Oct	12	$350	Certificate
Cleveland Clinic Hospital, Cleveland*	Helen Kaiser Walter J. Zeiter, M.D.	a-b-c	12 mos.	Oct	12	$200	Diploma
D. T. Watson School of Physical Therapy, Leetsdale, Pa.*	Dorothy Spark Jessie Wright, M.D.	a-b-d	12 mos.	Oct	25	$300	Diploma
Division of Physical Therapy of the School of Auxiliary Medical Services of the University of Pennsylvania, Philadelphia*	Kathryn Kelley G. M. Piersol, M.D. Dorothy E. Baethke	e f	12 mos. 4 yrs.	FebSept Sept	32 40	$600 $600	Certificate Cert. & Degree
University of Texas School of Medicine, Galveston*	G. W. N. Eggers, M.D. Ruby Decker	a-b-d	12 mos.	Jan	8	$149[2]	Cert. or Degree
Hermann Hospital, Houston, Texas*	O. O. Selke, Jr., M.D. Elizabeth Barkley	a-b-d	12 mos.	Oct	15	$300	Certificate
Baruch Center of Physical Medicine and Rehabilitation, Medical College of Virginia, Richmond*	Herbert Park, M.D. Susanne Hirt	a-b-d f	12 mos. 4 yrs.	Sept Sept	6‡	$300[2]	Diploma Degree
University of Wisconsin Medical School, Madison*	H. D. Bouman, M.D. Margaret A. Kohli	a-b-d f	12 mos. 4 yrs.	Sept FebSept	22 30	$60 Semes.[3]	Certificate Cert. & Degree

** Reprinted in part J. A. M. A. 146:197 (May 12) 1951.

1. Courses are so arranged that any of the entrance requirements will qualify students for training. a = Graduation from accredited school of nursing; b = Graduation from accredited school of physical education; c = Two years of college with science courses; d = Three years of college with science courses; e = Four years of college with science courses; f = High school graduation.

2. Nonresidents charged additional fee.

‡ Male as well as female students admitted.

3. Effective July 1, 1952, tuition will be $262.50 for each of the first three semesters, and $112.50 for the fourth semester, making a total of $900.00 for two years.

APPROVED SCHOOLS OF OCCUPATIONAL THERAPY **

Council on Medical Education and Hospitals of the American Medical Association

Name and Location of School	Director and Medical Director	Entrance Requirements	Duration of Course[1]	Classes Begin	Graduates in 1950	Tuition per Year	Certificate, Diploma, Degree
University of Southern California, Los Angeles*	Margaret S. Rood	Degree	18 mos.	Varies	12	$594	Certificate
	J. B. Armstrong, M.D.	High sch.	5 yrs.	Varies	19	$540	Cert. & Deg.
Mills College, Oakland, Calif.	Elsa H. Hill	Degree	2½ yrs.	FebSept	2	$250	Certificate
San Jose State College, San Jose, Calif.*	S. M. Dorinson, M.D.	High sch.	5 yrs.	FebSept	4	$650	Cert. & Deg.
	Mary D. Booth	Degree	18 mos.	Varies	1	$ 28.50	Certificate
University of Illinois College of Medicine, Chicago*	Charles Ianne, M.D.	High sch.	45 mos.	Varies	13	$ 28.50	Cert. & Deg.
	Beatrice D. Wade	High sch.	5 yrs.	MarSept	13	$110	Degree
State University of Iowa, Iowa City*	S. W. Olson, M.D.	.....	.....	.....	...	.....	.....
	Marguerite McDonald	.....	19 mos.	FebSept	2	$144[2]	Certificate
University of Kansas, Lawrence	W. D. Paul, M.D.	High sch.	46 mos.	FebSept	5	$144[2]	Cert. & Deg.
	Nancie B. Greenman	High sch.	45 mos.	FebSept	16	$135[2]	Degree
Boston School of Occupational Therapy, 7 Harcourt St., Boston*	D. L. Rose, M.D.	.....	.....	.....	...	.....	.....
	Marjorie B. Greene	Degree	2 yrs.	Sept	13	$500	Diploma
Wayne University, Detroit*	A. W. Reggio, M.D.	High sch.	5 yrs.	Sept	21	$500	Degree
	Barbara Jewett	Degree	19 mos.	Varies	1	$150	Certificate
Kalamazoo School of Occupational Therapy, Kalamazoo, Mich.*	F. A. Weiser, M.D.	High sch.	46 mos.	Varies	2	$150	Degree
	Marion R. Spear	Degree	18 mos.	FebSept	3	$ 75[2]	Diploma
Michigan State Normal College, Ypsilanti, Mich.*	R. B. Burrell, M.D.	1 yr. coll.	4 yrs.	FebSept	23	$ 75[2]	Dipl. & Deg.
	Frances Herrick	High sch.	5 yrs.	FebSept	6	$ 67.50[2]	Cert. & Deg.
University of Minnesota, Minneapolis*	V. L. VanDuzen, M.D.	.....	.....	.....	...	.....	.....
	Borghild Hansen	High sch.	40 mos.	Sept	12	$126[2]	Degree
College of St. Catherine, 2004 Randolph, St. Paul	F. J. Kottke, M.D.	.....	.....	.....	...	.....	.....
	Sister Jeanne Marie	High sch.	4½ yrs.	Varies	24	$225	Degree
Washington University School of Medicine, St. Louis*	J. M. Ryan, M.D.	.....	.....	.....	...	.....	.....
	Erna L. Rozmarynowski	Degree	11-14 mos.	Sept	—	University	Certificate
University of New Hampshire, Durham*	R. A. Moore, M.D.	2 yrs. coll.	28 mos.	Sept	14	University	Degree
	Esther Drew	High sch.	5 yrs.	Sept	8	$200[2]	Cert. & Deg.
Columbia University College of Physicians and Surgeons, New York City*	J. A. MacDonald	.....	.....	.....	...	.....	.....
	Marjorie Fish	Degree	17 mos.	Sept	20	$600	Certificate
New York University School of Education, New York City*	W. B. Snow, M.D.	2 yrs. coll.	27 mos.	Sept	10	$600	Degree
	Frieda J. Behlen	1 yr. coll.	.....	FebSept	3	$500	Certificate
Ohio State University, Columbus*	John Sawhill, M.D.	High sch.	4½ yrs.	FebSept	26	$500	Cert. & Deg.
	Martha E. Jackson	High sch.	4 yrs.	Varies	15	$ 90[2]	Degree
Philadelphia School of Occupational Therapy of the School of Auxiliary Medical Services of the University of Pennsylvania, Philadelphia*	R. H. Jacques, M.D.	.....	.....	.....	...	.....	.....
	Helen S. Willard	Degree	18 mos.	Sept	21	$600	Certificate
Texas State College for Women, Denton	J. C. Yaskin, M.D.	High sch.	5 yrs.	Sept	1	$600	Degree
	Fanny B. Vanderkooi	Degree	18 mos.	FebSept	...	.....	Certificate
Richmond Professional Institute, 901 W. Franklin St., Richmond, Va.*	O. T. Woods, M.D.	High sch.	5 yrs.	FebSept	5	$ 50	Degree
	H. Elizabeth Messick	High sch.	4 yrs.	Sept	5	$200	Degree
College of Puget Sound, 18th and Warner Sts., Tacoma, Wash.*	J. E. Barrett, M.D.	Degree	10-18 mos.	FebSept	4	$182+	Certificate
	Edna-Ellen Bell	.....	2 yrs.	FebSept	...	$400	Certificate
University of Wisconsin, Madison*	A. J. Hermann, M.D.	High sch.	5 yrs.	FebSept	5	$350	Cert. & Deg.
	Caroline G. Thompson	High sch.	5 yrs.	Sept	12	$120[2]	Cert. & Deg.
Milwaukee-Downer College, Dept. of Occupational Therapy, 2512 E. Hartford Ave., Milwaukee	H. D. Bouman, M.D.	.....	.....	.....	...	.....	.....
	Henrietta W. McNary	2 yrs. coll.	3 yrs.	Sept	2	$350	Diploma
Mount Mary College, 92d and Burleigh, Milwaukee	M. C. Borman, M.D.	High sch.	5 yrs.	Sept	20	$350	Dipl. & Deg.
	Sister Mary Arthur	High sch.	5 yrs.	Sept	14	$260	Cert. & Deg.
	J. C. Griffith, M.D.	.....	.....	.....	—	.....	.....

** Reprinted J. A. M. A. 146:198 (May 12) 1951.
1. Duration of course is expressed in academic years or in number of months.
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PHYSICAL MEDICINE AND REHABILITATION **

The following services are approved by the Council on Medical Education and Hospitals, and the American Board of Physical Medicine and Rehabilitation. Residencies in this specialty have been approved without specifying the number of years for which they are accredited. The Board will give appropriate credit for training in these hospitals on an individual basis.

Hospitals, 45; Assistant Residencies and Residencies, 87.

Name of Hospital	Location	Chief of Service	Inpatients Treated	Number of Treatments	First Year Residencies Offered[3]	Total Residencies Offered[3]	Beginning Stipend (Month)
UNITED STATES ARMY							
Letterman Army Hospital★	San Francisco	R. C. Psaki	4,231	116,264	....	....	.....
Fitzsimons Army Hospital★	Denver	H. B. Luscombe	7,045	250,440	....	....	.....
Army Medical Center★	Washington, D. C.	J. H. Kuitert	5,224	344,228	1	4	.....
VETERANS ADMINISTRATION							
Veterans Admin. Hospital★[1,2]	Long Beach, Calif.	Roy H. Nyquist	3,305	182,286	1	1	.....
Veterans Admin. Hospital[1,2]	Denver	C. C. Hoffman	731	11,804	1	1	.....
Veterans Admin. Hospital[1]	Hines, Ill.	L. B. Newman	5,135	463,131	4	4	.....
Veterans Admin. Hospital[1,2]	Whdsworth, Kan.	L. Blau	2,471	174,247	1	2	.....
Veterans Admin. Hospital[1,2]	Framingham, Mass.	F. Friedland	7,100	214,000	1	3	.....
Veterans Admin. Hospital[1,2]	New York City	A. S. Abramson	4,196	302,119	1	3	.....
Veterans Admin. Hospital[1,2]	Cleveland	H. T. Zankel	1,646	78,194	1	1	.....
Veterans Admin. Hospital[1,2]	Portland, Ore.	E. W. Fowlks	4,369	112,456	1	2	.....
Veterans Admin. Hospital[1]	Aspinwall, Pa.	S. Machover	1,957	56,412	1	1	.....
Veterans Admin. Hospital[1]	Memphis, Tenn.	F. I. Mahoney	10,090	152,031	....	....	.....
Veterans Admin. Hospital★[1,2]	Houston, Texas	B. L. Boynton	1,682	60,589	1	2	.....
Veterans Admin. Hospital★[1,2]	Milwaukee	R. Piaskoski	16,084	209,092	....	....	.....
NONFEDERAL							
Los Angeles County Hospital★[1,2]	Los Angeles	E. Austin	.....	93,906	....	1	178
White Memorial Hospital★[1,2]	Los Angeles	F. B. Moor	39,608	39,608	1	1	132
University of Colorado Medical Center Colorado General Hospital★[1,2]	Denver	H. Dinken	2,177	38,381	1	2	150
State of Connecticut Veterans Home and Hospital[1,2]	Rocky Hill, Conn.	N. K. Covalt	663	63,375	....	3	253.34
George Washington University Hospital[1,2]	Washington, D. C.	C. S. Wise	2,433	15,563	....	....	130
Emory University Hospital★[1,2]	Emory Univ., Ga.	R. L. Bennett	1,001	15,846	....	1	250
Georgia Warm Springs Foundation[1,2]	Warm Springs, Ga.	R. L. Bennett	998	114,110	1	4	250
Michael Reese Hospital★[1,2]	Chicago	C. Molander	3,589	30,929	1	1	25
Northwestern University Medical Center[1,2]	Chicago		13,752	43,409	....	....	50
Research and Educational Hospitals★[1,2]	Chicago	F. A. Hellebrandt	12,266	12,266	1	3	60
University of Kansas Medical Center★[1,2]	Kansas City, Kan.	D. Rose	2,563	49,649	....	1	125
Massachusetts General Hospital★[1,2]	Boston	A. L. Watkins	3,039	33,483	....	2	66.67
University Hospital★[1]	Ann Arbor, Mich.	J. W. Rae, Jr.	.....	20,659	2	6	134.16
University of Minnesota Hospitals★[1,2]	Minneapolis	F. J. Kottke	14,007	25,194	2	6	142.50
Mayo Foundation[1,2]	Rochester, Minn.	F. H. Krusen	.....	.....	2	6	150
Barnes Hospital★[2]	St. Louis	S. Mead	9,572	9,572	....	1	25
Bellevue Hospital Center—Division III—New York University College of Medicine★[1,2]	New York City	H. A. Rusk	1,082	83,147	4	7	80
Goldwater Memorial Hospital★[1,2]	New York City	M. Dacso	674	44,446	1	2	90
Hospital for Joint Diseases★[1,2]	New York City	J. Weiss	.....	90,407	1	2	60
Hospital for Special Surgery[2]	New York City	K. G. Hansson	19,388	37,284	1	1	160
Metropolitan Hospital[1,2]	New York City	J. Tobis	1,023	24,788	....	....	.....
Mount Sinai Hospital★[1,2]	New York City	W. Bierman	8,464	32,947	1	1	50
New York City Hospital★[1,2]	New York City	F. K. Safford, Jr.	1,030	37,080	1	1	160
Presbyterian Hospital★[1,2]	New York City	R. C. Darling	5,011	175,061	1	3	208.33
St. Luke's Hospital★[1,2]	New York City	R. Muller	1,099	115,572	1	1	60
Rehabilitation Hospital[1,2]	West Haverstraw, N. Y.	M. Hoberman	517	332,205	1	1	225
Cleveland Clinic Hospital[1,2]	Cleveland	W. J. Zeiter	16,638	36,957	1	3	150
University Hospitals							
Ohio State University Hospital[1,2]	Columbus, Ohio	R. E. Worden	1,245	15,894	....	....	125
Hospital of the Univ. of Pennsylvania★[1,2]	Philadelphia	G. Piersol	2,771	45,549	....	1	.....
Philadelphia General Hospital★[1,2]	Philadelphia	A. Martucci	1,225	66,802	2	2	112

The Star (★) indicates hospital approved for intern training.
1 Residencies open to women.
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3 Includes fellowships.

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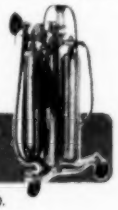

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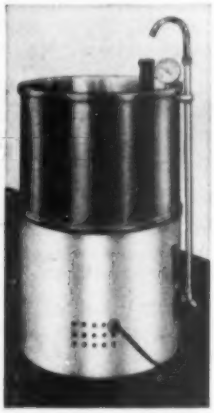

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American Congress of Physical Medicine and Rehabilitation — 31st Annual Session, The Palmer House, Chicago, August 31 through September 4, 1953. Walter J. Zeiter, M.D., Chairman, Convention Committee, 30 North Michigan Ave., Chicago 2.

Chicago Society of Physical Medicine and Rehabilitation — Regular monthly meetings, September through May, every fourth Wednesday. Dr. I. F. Hummon, Secretary-Treasurer, 30 N. Michigan Ave., Room 1429, Chicago.

New York Society of Physical Medicine — Monthly meetings held First Wednesday. Madge C. L. McGuinness, M.D., Secretary, 48 E. 62nd St., New York 21, N. Y.

Pennsylvania Academy of Physical Medicine and Rehabilitation — Regular meetings on third Thursday of month, held bi-monthly. Secretary, Charles A. Furey, M.D., 2201 St. James St., Philadelphia 3, Pa.

American Occupational Therapy Association — Annual Conference, November 13-20, 1953, Shamrock Hotel, Houston, Texas. Marjorie Fish, OTR, Executive Director, 33 West 42nd Street, New York 18, N. Y.

American Physical Therapy Association — Annual Conference, June 15-19, Baker Hotel, Dallas, Texas. Mildred Elson, Executive Director, 1790 Broadway, New York 19, N. Y.

International

World Congress of the World Confederation for Physical Therapy — London, England, September 7-12, 1953. Secretary, Miss M. J. Neilson, Chartered Society of Physiotherapy, Tavistock House, South, Tavistock Square, London, W.C. 1, England.

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